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Lighthouses and Buoys of New York Harbor

BY JAMES PATTISON

With the opening of Ambrose channel, the subject of lighthouse illumination of New York harbor has received most careful attention. Less than a decade ago the ocean entrance from the lower to the upper bay was crooked and narrow and beset with treacherous shoals through which only the most skillful and experienced pilots could navigate with safety. Ocean traffic to this port was steadily growing, and each year witnessed vast increases in the size and speed of vessels, with no apparent limitation in sight. Formerly the only sources of light for lighthouses were oil and oil gas, the former burned in a wick, the latter with a flat flame; both were feeble and of very limited range. But to-day conditions are different. The great liner making the port of New York at night is now guided by the powerful rays of the electric arc, the acetylene flame, and the incandescent light of Pintsch gas, and petroleum vapor. A broad, straight and deep channel now pierces the shoals of the lower bay, through which the ocean greyhound may pass with unabated speed to the safety of the upper bay.

FIG. 1.—SENTINELS OF THE SEA

Modern Aids to Navigation

The aids to navigation in New York Bay, which will be briefly described, comprise lighthouses whose source of illumination is electricity or oil vapor; beacons; combined lighted acetylene and warning buoys; combined lighted Pintsch gas and warning buoys; automatic whistling and bell buoys; conical and tubular buoys of large size; spar buoys and can and nun buoys of various sizes. Other aids are lightships, submarine warning stations and wireless telegraph stations.

Light Signals

The lighted aids have distinctive characteristics, viz., fixed lights, revolving lights and flashing lights. The single fixed light as established at Sandy Hook light station and Conovar beacon light station, consists of an oil vapor light within a fixed or stationary drum lens. (For fixed range lights a bulls-eye or holophoto is used.)

The revolving lights, such as Navesink light station and Nomer Shoal light station, are employed only for large lights of the first, second, third and fourth orders, and are equipped with lenses sometimes of the most wonderful and complicated construction, to produce flashes of different durations and intensities. The lens is supported on a table or float, which is revolved around the light in a bath of mercury by means of a falling weight or spring clock.

The flashing light is used on buoys and beacons and is produced by the pressure of the illuminating gas (acetylene or Pintsch gas) upon a flexible bellows or diaphragm, which operates a valve or valves controlling the flow of gas to the burner. A tiny pilot burner maintains a light at all times and intermittently lights the main flame as gas escapes with each impulse of the diaphragm. Thus light and dark intervals are produced.

Fixed drum lenses are also used with this system and vary in diameter from 8 to 15 inches. Unaided, the naked light

would not carry far and its beams would be diffused and scattered in all directions. Therefore, one of the subjects which received the earliest attention was the means for collecting and concentrating the light rays and projecting them in a horizontal plane. For this purpose two systems were developed, the first being the Caloptric or reflector system, now almost obsolete, the second the Droptic or lens system, used to-day in all modern lighthouses and buoys. In passing, it may be of interest to note that all cut-glass lenses used in the lighthouse and buoys of the United States are made in Germany, France or England, and that all attempts (and many have been made) to manufacture them in this country have failed.

Increase in Light Power

The increases in intensity of light due to the use of new illuminants are very high. For example, by substituting an oil-vapor burner for a circular wick burner of the same diameter the power of an apparatus is increased about three and one-half times. The increase in power of the electric arc over the circular wick burner is still greater, but the use of electricity is still attended with too many disadvantages to permit its general extension to lighthouse illumination. The gain in lighting power of acetylene over oil gas (flat flame) is about 4 to 1, acetylene producing 45 candles per foot, oil gas 11. The gain in the lighting power of oil gas (Pintsch gas) burned in an incandescent mantle, over the flat flame, is also about 4 to 1. These increases in light power have all been effected within the last decade.

Sound Signals

Of the sound signals used as aids to navigation in New York harbor, the most common types are the bell buoys and whistling buoys, both of which are frequently combined with light signals—e. g., the Ambrose channel entrance buoy is of the latter type (combination light and whistle), as shown in Fig. 8.

The whistle on these buoys is sounded by the action of the waves on what is known as the Courtenay principle. A long tube descending from the buoy body has an area of about 7 square feet, and extends to the top of the body or flotation chamber. One or two smaller tubes connect from it to the whistle valve, which is provided with solid rubber balls, making a tight seat. The whistle, which varies from 8 inches to 12 inches in diameter, is fastened to the valve and protected by the superstructure which carries the lantern. As the buoy rises on a wave air is sucked in through the valve, and as the buoy descends is compressed and forced violently through the whistle, producing a loud moaning noise.

The bell buoys are familiar to everyone who sails down the bay. The trinity type with four hanging tappers is the most usual form. This type is illustrated in Fig. 4, where it is being taken in to be cleaned and painted.

The Ambrose channel light vessel is equipped with a 12-inch steam whistle, which sounds a blast every fifteen seconds in foggy weather. North Hook beacon and Old Orchard Shoal light stations are equipped with automatic compressed air sirens, while Nomer Shoal light station has a bell which is operated by machinery, striking once every thirty seconds. A similar bell signal is installed at Coney Island light station.

FIG. 2.—COLLECTION OF BUOYS AT LIGHTHOUSE DEPOT

A Trip Down the Harbor

Having thus briefly described the various kinds of modern light and sound signal apparatus employed in New York harbor, the reader is invited in fancy for a trip on the lighthouse tender to the lightships, and returning up the Ambrose channel, will have each of the important light stations pointed out in the order they appear to the incoming navigator.

We embark at the General Lighthouse Depot, Tompkinsville, S. I., where the work of loading on supplies is proceeding. The powerful derrick of the tender picks up a ten-ton steel buoy from the dock and places it gently on the forward deck. Then follow two gas tanks, each weighing 1,500 pounds

and containing a supply of acetylene sufficient to maintain the buoy lighted for six months or a year without interruption. The huge buoy lantern, weighing one-fourth of a ton, is then swung aboard.

Soon we are under way, and reaching the station where the big A G A buoy is to be placed, the captain sings out his orders and the anchor plunges down to the music of chains rattling through the hawse pipe. The buoy is lifted from the deck and lowered into the water, where it is anchored to a cast iron sinker of hemispherical form or a square block of concrete containing iron punchings to give it additional weight, or perhaps an ordinary anchor, depending upon the nature of the bottom and the force of the currents. The buoy afloat, a couple of deck hands mount on it and remove the covers from the tank pockets, the tanks are lowered into place, and the gas piping coupled up, after which the covers are replaced. The lantern is then lifted on to the top of the framework, pared with less than 12 candles with the old style of burner with naked flame. The average life of mantles on buoys taken from over 2,000 buoys is said to be three months. Fig. 5 illustrates a Pintsch mantle being renewed.

At length the Ambrose channel lightship is reached, and after transferring supplies we prepare for the return trip to the depot.

The Ambrose channel lightship is a straw-colored vessel with two masts and one funnel which also carries the steam fog whistle. It is equipped with wireless. On the foremast is carried a lantern containing an electric arc light, which shows a flashing light of 12 seconds duration, followed by eclipses of 3 seconds. This light is visible 13 miles. She carries a crew of about 15 men.

The next light visible is the great gas and whistling buoy at the intersection of the Gedney and Ambrose channels. This buoy is known as the Willson buoy, and employs acety-

FIG. 3.—LIGHTHOUSE TENDER TULIP

more than 16 feet above the water, and bolted down. The gas piping is coupled up and joints are tested for leaks with soapsuds. The valves are then opened and a match is applied to the burner. Soon the anchor is weighed and the tender gets under way again, heading for the upper Pintsch buoy at Gedney channel.

The pressure gage on this buoy indicates the need of a fresh charge of gas. The gas used on these buoys is made from crude oil at a station on shore, and is pumped into small steel containers or bottles to a pressure of 100 atmospheres, so that it is easily transported to the buoys. To charge the buoy a high-pressure hose is coupled between the tank and the buoy and the gas is allowed to flow in until it attains a pressure in the buoy of 12 atmospheres. This operation is being performed in the picture shown in Fig. 9.

The modern Pintsch gas buoy light employs a spherical incandescent mantle in which the gas is burned at 1 pound pressure, producing a light of 40 candles per foot, as compared with less than 12 candles with the old style of burner with naked flame. The average life of mantles on buoys taken from over 2,000 buoys is said to be three months. Fig. 5 illustrates a Pintsch mantle being renewed.

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The next light visible is the great gas and whistling buoy at the intersection of the Gedney and Ambrose channels. This buoy is known as the Willson buoy, and employs acetylene as an illuminant. Its characteristic is 5 seconds light, followed by an eclipse of 5 seconds. The gas is generated from calcium carbide within the buoy itself. The generating chamber contains about 3,000 pounds of carbide at a charge, and as this carbide is capable of producing 4½ cubic feet of acetylene per pound, there is altogether available 13,500 cubic feet of gas, sufficient to keep the buoy lighted for a year or more. Calcium carbide is made by fusing together a mixture of coke and lime in an electric arc furnace. When broken up it resembles granite rock. Acetylene produces a light of great brilliancy, comparable only to sunlight.

Away on the port side is seen the quick, blinding flash of Navesink light station, an electric arc light with a first-order lens, producing a light of more than 1,000,000 candles, visible at 22 miles. This type of light station is termed a landfall light.

The range lights on Staten Island now come in view. These are high-power incandescent oil-vapor lights. The in-

FIG. 4.—PICKING UP AN OFD BELL BUOY

candescent oil-vapor light is steadily replacing the oil lamp with circular wick. It gives a light of many times greater power with a smaller consumption of oil. Briefly, it consists of a small oil tank connected to a smaller air tank, in which air is compressed by a hand pump to a pressure of about 60 pounds per square inch. The oil is forced through a very fine tube to the vaporizer in the burner, where it is vaporized and burned in a mantle. The mantles vary from 1⅜ inches to 2⅛ inches in diameter, and from about 4 to 6 inches long. The light produced is dazzlingly white. Incandescent oil vapor burners are now used in all large modern lighthouses. The front range is equipped with a fog signal known as a Daboll trumpet.

We now enter the Ambrose channel, which is guarded at its entrance by an A G A combination light and whistling buoy. This buoy is on the port side and has a white light with the following characteristics: two-tenth second light, followed by four-tenth second eclipse. As we pass the dismal howl of the whistle may be heard. As previously described, this type of buoy is provided with tanks containing dissolved acetylene.

These tanks or steel bottles are filled with an earthy porous mass of about 80 percent porosity, which precludes the spreading of an explosion wave. This mass is saturated with acetone, a liquid hydrocarbon possessing the remarkable property of absorbing 25 times its own volume of acetylene for each atmosphere of pressure, so that a bottle 22 inches in diameter by 70 inches long contains at 10 atmospheres about 1,100 cubic feet of gas. This gas passes up into the lantern, where it is reduced in pressure to the fraction of a pound, after which it enters the flasher and the burner.

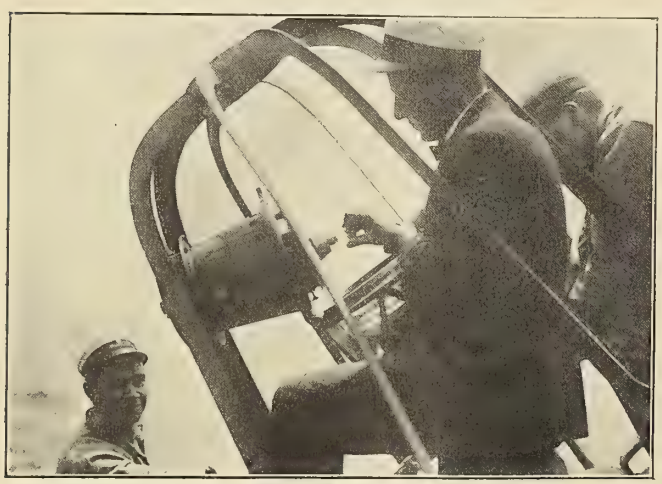

FIG. 5.—PUTTING MANTLE ON LAMP OF PINTSCH GAS BUOY

To the starboard we pass a Pintsch gas buoy with fixed red light; then alternately to port and starboard white and red buoy lights are passed, the red always on the starboard and the white on the port. Nun buoys (conical) are usually placed on the starboard side and can buoys (cylindrical) on the port.

Buoy after buoy is passed, and we soon leave behind the lights on the inner range of Sandy Hook. Away to the port we passed Old Orchard Shoal light station with its light visible 13 miles. Its fog signal is operated by compressed air from a small compressor run by a gasoline (petrol) engine. It produces a prolonged blast of 7½ seconds duration, followed by a silent period of like interval.

Coney Island light, on the westerly end of the island, is now visible, its red light flashing at intervals of 5 seconds It is visible about one-sixth further, or over 16 miles.

Soon the clanging of Fort Wadsworth bell-buoy is carried to the ear, and then we observe the flashing alternately red and white light of Fort Wadsworth light station. Here, in foggy weather, a bell is struck by machinery; one stroke, then

FIG. 6.—LAMP FOR A G A BUOY

a silent period of 15 seconds. On the easterly side of the Narrows is Fort Lafayette fog signal station, also equipped with a bell.

Off St. George, Staten Island, at the easterly entrance of Kill van Kull, is Robbins Reef light station, which is kept by a woman. It has a flashing white light visible 13 miles, and a compressed air fog siren.

As we swing into the depot again we see behind Robbins Reef, faint against the glaring lights of Manhattan, the torch of Liberty illuminating the world. On this imaginary trip we have only seen a few of the lights of New York harbor, but enough to realize how carefully Uncle Sam safeguards at night the gateway to the Metropolis of the New World.

Annual Report of the Secretary of the Navy

In his annual report for the fiscal year 1912, Honorable George von L. Meyer, Secretary of the Navy, urges strongly the passage of a bill creating a Council of National Defense made up of two Cabinet officers, four Senators, four Con-

FIG. 7.—HAULING AN ACETYLENE GAS BUOY ABOARD LIGHTHOUSE TENDER LARKSPUR

gressmen, two Army officers and two Navy officers. It is expected that such a council would tend toward and result in a better understanding and in a definite policy in the maintenance and upbuilding of the national defense.

As regards new construction, the Secretary points out that considering the number of dreadnoughts and battle cruisers as a measure of naval strength, if the Powers do not increase their present programmes, and if Congress authorizes only two

FIG. 8.—CLEANING AND ADJUSTING LAMP ON GOWANUS SHOALS BUOY

FIG. 9.—CHARGING PINTSCH BUOY WITH GAS

capital ships every year, the United States will have dropped from second to fourth place in strength. Furthermore, the supposition that the opening of the Panama Canal will double the strength of the fleet is erroneous, since it will not increase the number of ships available, but will only reduce the time necessary to transfer a vessel from one ocean to the other. To maintain and increase the strength of the United States as a naval power, a continuing annual building programme is urged as necessary. In the opinion of the Secretary, a total of forty-one battleships and a proportional number of other fighting and auxiliary vessels is the least that will place this country on a safe basis in its relation to the world powers. This number should be reached as soon as practicable, and then the fleet should be kept up to its standard strength by replacing obsolete vessels with new ones by a uniform yearly replacement programme. The General Board recommends that provision be made at the coming session of Congress for the addition of four battleships, two battle cruisers, sixteen destroyers, one destroyer tender, two transports, one ammunition ship, six submarines, one submarine tender, one supply ship, two gunboats, two seagoing tugs, one dry dock and one submarine testing dock. The battleships asked for will simply replace four battleships which will become obsolete after twenty years of service, and the numerical strength of the navy will not be changed. The policy of providing four destroyers for each battleship and one tender for each sixteen destroyers is urged as indispensable.

An Oil-Engined Coaster

BY GEORGE THOW

The first full powered oil-motor coasting cargo vessel was recently built in a shipbuilding yard at Ardrossan, on the Firth of Clyde. Although there are many motor cargo boats in Continental ownership, these have been designed with an eye to canal work as well. This Scotch vessel is for the usual coasting service, and will be employed in a trade that will take her to the largest ports and to compete with ordinary engined steamers. She is for a Glasgow owner, and will be run regularly on the round voyage between Glasgow, Liverpool, Cardiff and Dublin.

As a matter of fact the vessel was designed originally for reciprocating engines, and the intention to have oil engines installed was an afterthought. She is therefore somewhat fuller aft than she would be if firstly designed for motor propulsion, but advantage of this is taken to provide accommodation for the oil tanks.

In length the vessel is 147 feet, in breadth 25 feet, and in draft 10 feet. The builders are the Ardrossan Dry Dock & Shipbuilding Company, and the coaster will be classed 100 A-1 at Lloyd's. The motor selected is the four-cylinder Bolinder direct-reversible engine, using crude oil, having an indicated horsepower approximately of 500 and capable of giving a sea speed of fully 8½ knots. A Glasgow firm of engineers, Messrs. Douglas, Primrose & Company, have secured the engining contract. The Bolinder motor is a Swedish engine which has gained a good reputation on the Continent. A demonstration boat toured the British Isles, and the motor is being adopted by fishing craft. A large full-powered drifter was launched at Eyemouth a month or two ago, and is fitted with a 120 brake-horsepower Bolinder crude oil motor, and a 92-foot barge is, we understand, being built in this country to be engined with that make.

But before entering into details of the motor it may be stated that one of the reasons that induced the owner of the Ardrossan coaster to substitute an oil engine for steam was the increased gain in carrying capacity. As originally designed for steam the deadweight tonnage was calculated at 420 tons; the substituting an oil engine raises the deadweight capacity to 500 tons. There is also an important reduction in the wage bill of the engine-room staff, and the general costs of running are expected to be considerably under those of steam engines. Another advantage is that the machinery will not extend nearly so far forward as steam engines and boilers would do, and therefore practically the whole of the 'midship section of the ship will be available for cargo carrying. This is very serviceable in the coasting trade for quick loading and discharge, and is also advantageous for stowing awkward cargo in the shape of machinery, lengthy constructional ironwork, etc.

All the propelling machinery and oil tanks will be aft. When the vessel is light she can be trimmed by water tanks in the forepeak. In the construction of the oil tanks a departure is being made from the method adopted in some previous vessels built abroad. In these ships the frames were made exceptionally deep and the spaces covered over, thus forming tanks in the structure of the vessel itself; but in the Ardrossan boat special tanks will be made and fitted into the spaces between the frames, so that if necessary they can be removed at any time.

The propeller, which will be much smaller than that necessary for reciprocating engines and lower set, will be completely immersed in all stages of the vessel's trim. The revolutions will be over 200. To work the auxiliary plant a donkey boiler, fed with oil fuel from the same tanks that supply the main engine, is to give steam to the steam steering gear, steam capstans and steam cargo winches.

The Bolinder engine is made for marine work with either reversible propeller blades, for small craft, reversing gear, or direct reversible. The engine for the Ardrossan boat is of the direct reversible type. It is an engine of the modern two-cycle class, delivering a power impulse for each revolution of the flywheel. It has no valves, cams, gears or electric sparking device, and the construction is such that all the parts work automatically and cannot be thrown out of adjustment. On the up-stroke of the piston a partial vacuum is created in the enclosed crank case, causing the necessary charge of air to rush in at two opposite inlets. Near the end of the stroke an oil pump automatically injects the proper amount of oil through a nozzle into an ignitor ball. This ball has been previously heated to a dull red heat by a blow-lamp, so that the hot walls of this ball immediately convert the oil into vapor. The mixture of air and oil gas is then automatically fired, driving the piston downward, during which the charge of air previously drawn into the crank case is compressed, and when the piston approaches the end of the down-stroke it uncovers the exhaust port, permitting the burnt charge to escape through the silencer until its pressure reaches that of the atmosphere. Directly afterwards the transfer port on the opposite side of the cylinder is uncovered by the piston, thereby allowing the charge of air compressed in the crank chamber to rush into the cylinder, where it is deflected upwards by the shape of the top of the piston and caused to fill the cylinder, thereby expelling the remainder of the burnt charge. By means of two ports the ignitor ball is thoroughly cleaned of all deposit, as fresh air rushes through it, and thus powerful ignitions are ensured. All those operations described take place in the cylinder and crank case with every revolution

CANADIAN PACIFIC LINES.—Two new vessels of 15,000 gross tons each are being built at the Fairfield Works for the Pacific service of the Canadian-Pacific Railway. These vessels are 590 feet long, 68 feet beam and 46 feet depth. They are propelled by turbine machinery, and are designed to accommodate 200 first class, 100 second class and 800 third class passengers, making them the largest vessels with one exception trading between the American continent and Japan and China.

Experiments on the Fulton and the Froude*

BY PROF. C. H. PEABODY†

The objects of the experiments related in this paper are the investigation of the characteristics of towboats and the determination of favorable conditions. The applicability of steamboats for towing was so evident that forms and proportions were settled early in the history of steam navigation, being controlled, in part, by the ideas then prevalent concerning the action of screw-propellers and in part by the conditions of service which required simplicity and reliability in the hands of men economically available for boats of that class. The conditions of the service favor conservatism, and consequently the early types have been generally preserved, though there are instances of progressive designs that have broken away from tradition, specially for large sea-going towboats. The propellers used for towboats have habitually been four-bladed, with large area and wide tips, and have had a large pitch ratio, commonly from 1.3 to 1.5. The pitch ratio is controlled by the use of relatively slow engines, and the form of blade according to the old ideas concerning the action of screw-propellers, especially as applied to towing. Many designers have been of the opinion that both width of blade and pitch ratio could advantageously be reduced, and when circumstances appeared favorable have made such changes.

During the experiments made in the summer of 1911 on the *Froude* with propellers having various pitch ratios and widths of blades, advantage was taken of the opportunities to make experiments in towing and pulling; these experiments could not be reduced in time for presentation with other results, which is not to be regretted, as they can be conveniently presented here in connection with experiments on the *Fulton,* which is a typical harbor towboat made to one-third the size of its prototype the *Sotoyomo,* for which data are given by Naval Constructor D. W. Taylor, U. S. N., in the fifteenth volume of our *Transactions.* Speed trials were made of the *Sotoyomo* in 1907 near Mare Island navy yard, the model was towed in the model basin, and results of these investigations have been kindly furnished to me by the chief constructor, Admiral R. M. Watt, U. S. N.

The principal dimensions of the *Sotoyomo,* the *Manning* and the *Sonoma* (a new ocean towboat for the navy) are given for convenience in the following table. The *Manning* is given because it is the prototype of the *Froude,* and the *Sonoma* for comparison with the *Manning,* which has characteristics not unlike an ocean towboat. Thus we have in the

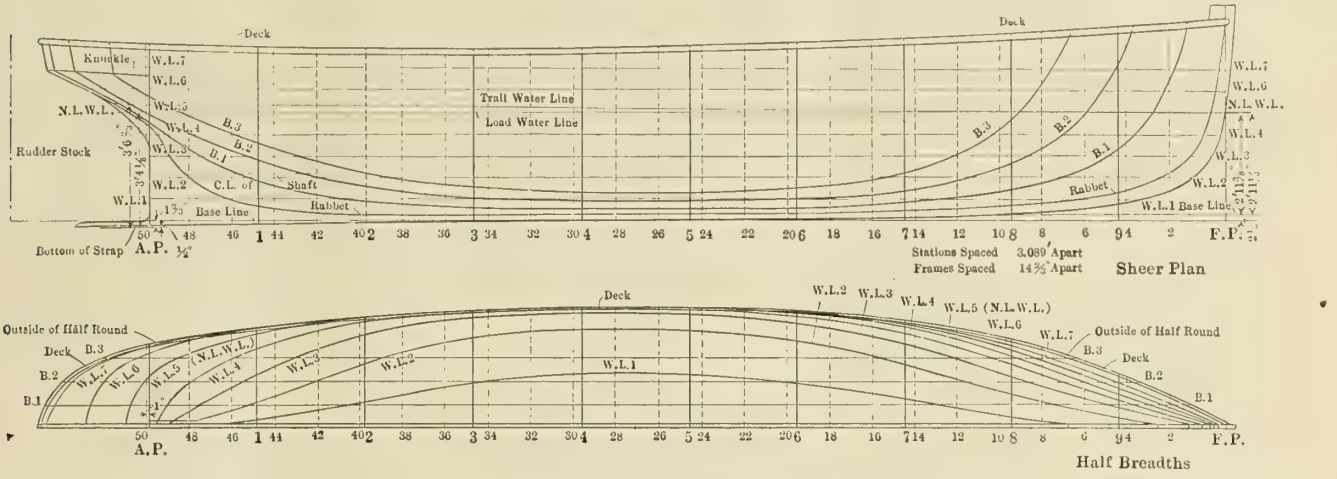

FIG. 1.—LINES OF THE FULTON. LENGTH (O. A.), 34 FEET 4 INCHES; LENGTH (N. L. W. L.) 31 FEET 9¼ INCHES; BEAM (N. L. W. L.), 7 FEET ⅛ INCH; DRAFT (MEAN TRIAL W. L.), 3 FEET 3 INCHES; DISPLACEMENT (M. T. W. L.), 22,160 POUNDS (S. W.); WETTED SURFACE (M. T. W. L.), 289 SQUARE FEET

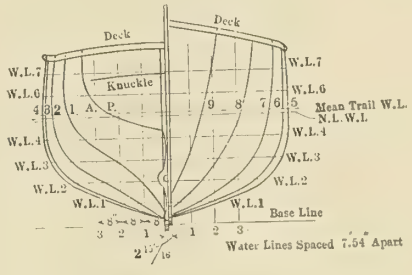

FIG. 2.—BODY PLAN

Fulton and the *Froude* little towboats of the two principal types.

	Length L. W. L.	Beam.	Mean Draft.	Displacement.	Speed, Knots.
Sotoyomo	92.7	21.	9.16	258*	10.5
Manning	188	32	12.3	1,000*	16
Sonoma	175	34	14.5	1,100*	14
Fulton	30.9	7	3.25	9.6†	6.4
Froude	37.6	6.4	2.52	8†	7.2

* Salt water. † Fresh water.

The lines of the *Manning* and the *Froude* can be found in the author's paper of last year and need not be repeated here. The characteristics of the experimental propellers are given here for convenient reference.

PROPELLERS FOR THE FROUDE, 1911

	Pitch Ratio.	Projected Area-ratio.
No. 1	0.8	0.61
No. 1A	0.8	0.50
No. 1B	0.8	0.44
No. 2	1.1	0.59
No. 2A	1.1	0.52
No. 2B	1.1	0.45
No. 3	1.5	0.60
No. 3A	1.5	0.53
No. 3B	1.5	0.44

These propellers all had oval blades with sharp edges and were correctly planed.

* A paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1912.

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The lines of the *Fulton* are given in Fig. 1; they are substantially the same as those of the *Sotoyomo*. The three experimental propellers had the following charactertistics:

PROPELLERS FOR THE FULTON, 1912.

	Pitch Ratio.	Projected Area-ratio.
No. 1	0.8	0.56
No. 2	1.0	0.53
No. 3	1.29	....

The propeller No. 3 was a close copy to one-third the size of the propeller of the *Sotoyomo*, which is represented by Fig. 3, made from a drawing kindly furnished by Admiral H. I. Cone, U. S. N., with the exception that the propellers of the *Fulton* had no rake. All the propellers were cast and had the surfaces smoothed but not planed; as is customary for such propellers there was some thickness near the edge which was rounded on the back to the edge. The propellers, which were made by the Hyde Windlass Company, of Bath, Me., were closely correct to pitch; the pitch ratios are so nearly correct that variations can have little, if any, effect on our results.

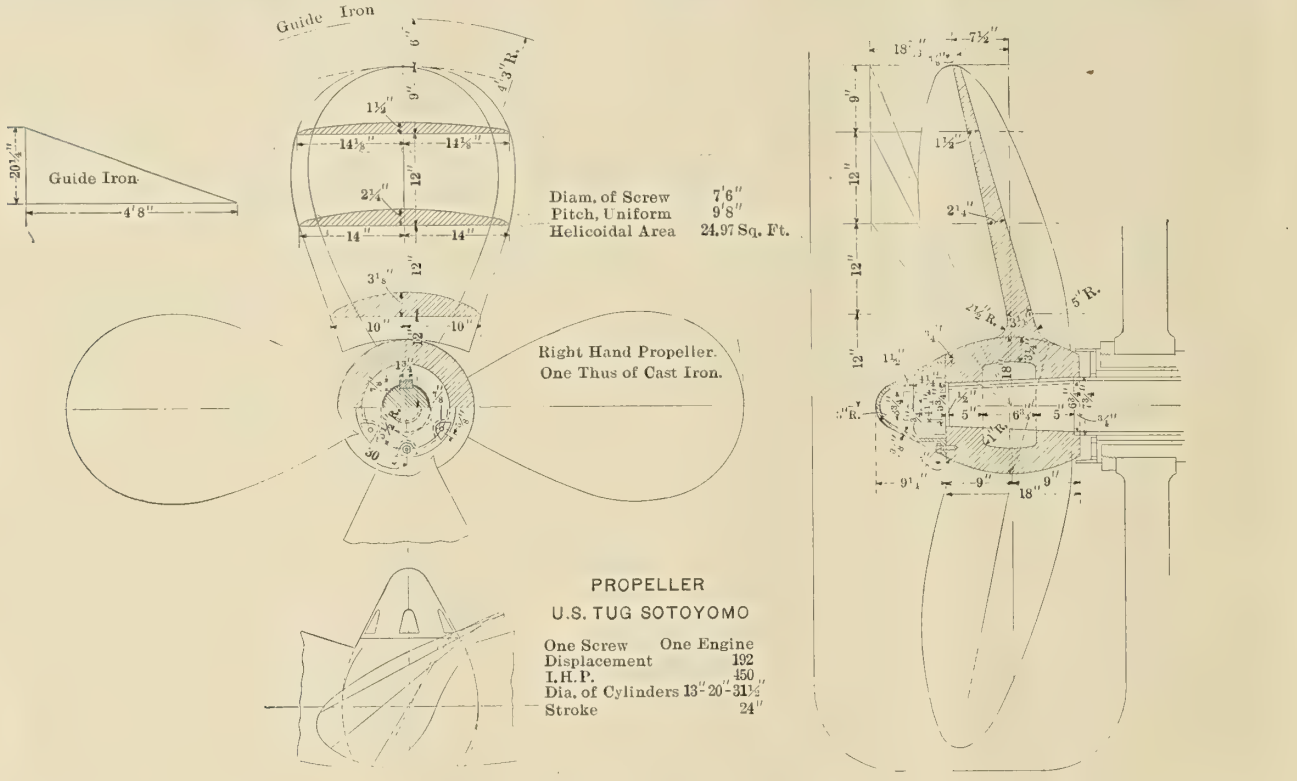

FIG. 3

The hull of the *Fulton* was built in the shops of the Massachusetts Institute of Technology; it had double-sawed oak frames spaced 15 inches apart, oak keel, keelson, stem, sternpost and beams, and was single-planked white ⅞-inch white cedar. The construction and general arrangement are shown by Fig. 4. Measurement after construction showed that the form was fair and true to the lines. In order to reduce wind resistance the boat was practically flush-decked, the 'midships being covered with light hatches that could be opened for convenience in installing and running the machinery. The boat was maneuvered from a cock-pit forward and was very handy under our system of indirect electric propulsion.

The machinery and apparatus used on the *Froude* in 1911 were transferred to the Fulton, and do not require description beyond that given in the former paper.

The tow-rope pull in both years was taken by the vertical arm of a bent lever; the horizontal arm of the lever pulled directly on a good spring balance, a dash pot being used to reduce vibration. This device was found to be convenient and as delicate as conditions warranted. The points for a series of tests came on a fair curve, and appeared to have an error of not more than 1 percent.

During the experiments of 1911 the *Froude* towed a drag made of three railroad ties bolted together in a triangle and towed from the apex. During the experiments of 1912 the *Fulton* towed the *Froude*, which had a plank bolted across the stern to augment its resistance. The drag used in 1911 was effective, towed steadily and was not affected by wind action; it was very inconvenient, especially during turns. The *Froude* was considered to tow more like a barge, and with a steersman aboard was more convenient; it was affected by wind resistance.

Considering the long time required for a towing test over a measured course, especially for the turns, and the desirability of being able to choose sheltered parts of the basin, we decided to try measuring speed by a propeller log set forward of the boat. The propeller was 8 inches in diameter, had a pitch of 14 inches, and three blades. It was carried by a vertical rod supported by an outrigger above water, had its axis 9 inches below the surface, and was set 8 feet forward from the stem of the boat. Trials of this log with the *Fulton* running free over the measured course indicated that this log would give satisfactory results; in use, especially when there was some wind, it appears to have been influenced by surface drift, and in consequence the determination of speed on the towing tests is affected by errors that may be 2 or 2½ percent. This is indicated by the dispersion of points for a curve and by check runs over the measured course. This use of the log during towing was the only divergence from tests of the two preceding years.

Influence of Blade Area

A towboat, especially of the harbor type, has three various kinds of duty, namely: (1) To run free, passing from place to place, and perhaps seeking business in face of competition; (2) towing at a reduced speed, commonly at half speed or somewhat more, and (3) pulling or pushing a ship into her berth at very slow speed, or nearly without speed.

Running-free towboats differ from other classes only in that, being high-powered to enable them to tow, they have relatively high speed even though not designed with that in view.

To have a ready standard of comparison in our discussion of the effect of width of blade and area ratio, let us consider that the standard Admiralty blade proposed by Froude has been found sufficient for all classes of ships (excepting towboats), until cavitation has brought about the use of wide blades in certain cases. Now this standard blade has a maximum developed width of 0.2 of the diameter of the propeller, which gives a developed area ratio for four blades of 0.36; the projected area ratio is somewhat less, depending on the pitch. The experiments on model propellers by Naval Constructor Taylor show that such an area ratio is preferable for the generality of propellers, but that the ratio may be increased up to 0.48 without appreciable disadvantage. From a study of Mr. Taylor's experiments and of the tests about to be related, I am ready to advise the use of a projected area ratio of about 0.5 for four-bladed propellers for all towboats. The minimum area ratio of the propellers used on the *Froude* in 1911 is 0.44.

In considering the effect of width of blade and projected area ratio let us take up the results of experiments on the *Froude* with the several propellers given in the table for each of the three several duties of a tow-boat, namely, running free, towing and pulling (or pushing).

For running free we may refer to the author's paper submitted last year, which gives the results of tests with the propellers given in this paper. A reference to this paper will show that the curves of power on speed for a given pitch ratio and for all projected area ratios from 0.44 to 0.60 are practically identical; the several curves for the various areas can be distinguished, but the separation is no more than must be attributed to the unavoidable error of experiment. This result is unexpected, because the increase of area ratio for the experimental propellers of Mr. Taylor is accompanied by a loss of efficiency amounting to 3 or 4 percent out of 60 to 66 percent.

The effect of area on towing is shown by Fig. 5, which gives all the points representing the separate runs and also mean curves, with brake-horsepower plotted on speed. Points for tests with the original width of blade are represented by triangles, the intermediate widths have crosses, and the least widths have circles. For the pitch ratios 0.8 and 1.1 all points lie on or closely adjacent to the curves; for the pitch ratio 1.5 the points show a little dispersion. It would be possible to draw three separate curves for this pitch ratio of 1.5, and in that case the curve for the least area ratio (0.44) would lie the lowest and indicate a slight advantage for the narrower blade. In reading these diagrams, which for convenience are put on one plate, it will be noted that there are three base lines selected so as to separate the curves for the several pitch ratios.

On Fig. 6 the results of our measurements of thrust of the propeller-shaft are plotted in the same manner as the power. These results are quoted because they represent a direct measurement in which we have great confidence, and as the points and curves have the same characteristics as those for power on Fig. 5 they give direct evidence of the reliability of our power curves.

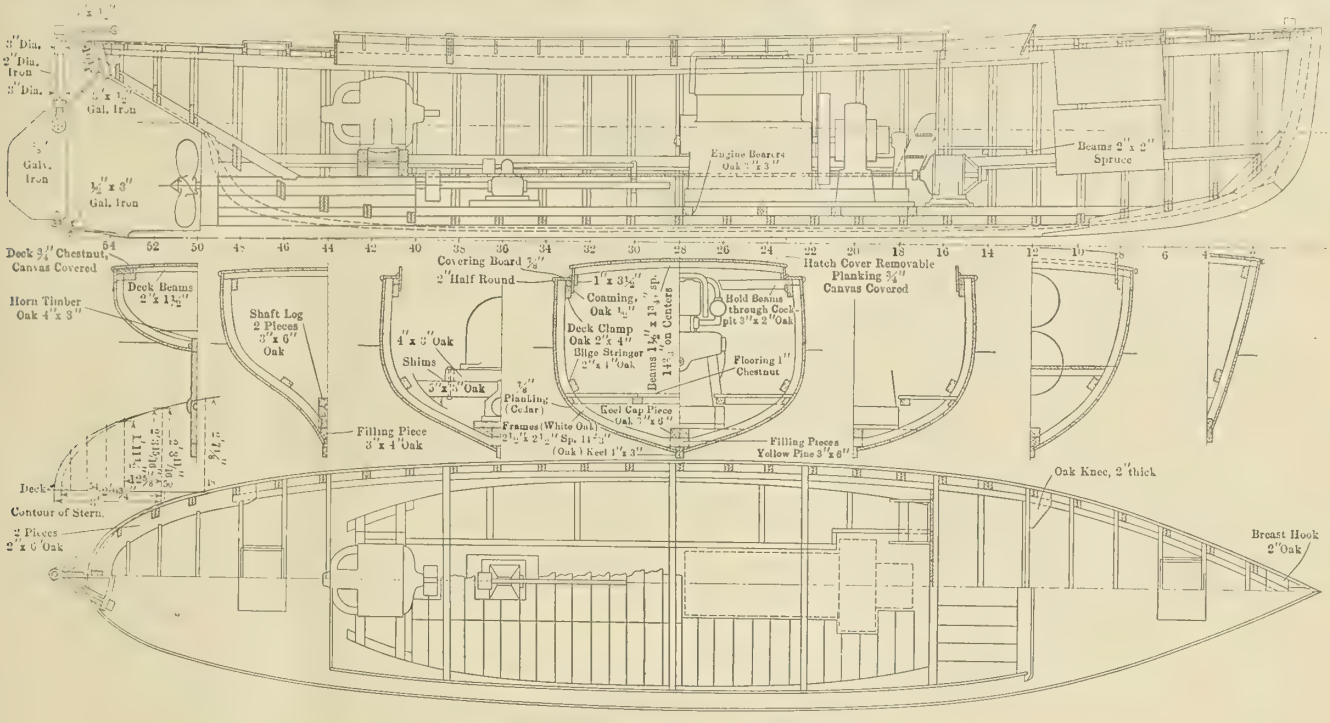
Deck ¾" Chestnut, Canvas Covered
Horn Timber Oak 4"x 3"
Deck Beams 2"x 11½"
Shaft Log 2 Pieces 3"x 6" Oak
Filling Piece 3"x 4" Oak
Deck
Contour of Stern
2 Pieces 2"x 6" Oak
Covering Board ⅜"
2" Half Round
Deck Clamp Oak 2"x 4"
Bilge Stringer 2"x 1" Oak
4"x 3" Oak Shims
Planking (Cedar)
Frames (White Oak)
Keel Cap Piece Oak 7"x 9"
Keel 1"x 3"
Engine Bearers Oak 3"x 3"
Beams 2"x 2" Spruce
Hatch Cover Removable Planking ¾" Canvas Covered
Hold Beams through Cockpit 3"x 2" Oak
Flooring 1" Chestnut
Filling Pieces Yellow Pine 3"x 6"
Oak Knee, 2" thick
Breast Hook 2" Oak

FIG. 4.—CONSTRUCTION PLANS OF THE FULTON

For our pulling experiments the *Froude* was secured by a line from our weighing beam to a pile of the draw of the Harvard Bridge. The motor was allowed to run at various powers and the tow-line pull was read directly on the spring balance, allowing, of course, for the inequality of the arms. The results are shown by Fig. 7 for the original area ratio of about 0.6 only; similar experiments with narrower blades were not made, partly because of lack of time and partly because their importance was not realized. The experiments gave no indication of breaking of the propeller race except at high powers for the largest pitch ratio.

From these experiments the conclusion to my mind is direct and positive, namely, that the width of blade and the projected area ratio of a propeller have little or no influence on the performance of a towboat when (1) running free, or (2) towing. The evidence with regard to pulling is incomplete, but I believe that with a pitch ratio not greater than 1.3, a moderate area ratio will avoid breaking the race. It is to be borne in mind that our least area ratio is 0.44, which is nearly a fourth greater than the developed area ratio that has been found sufficient for general service.

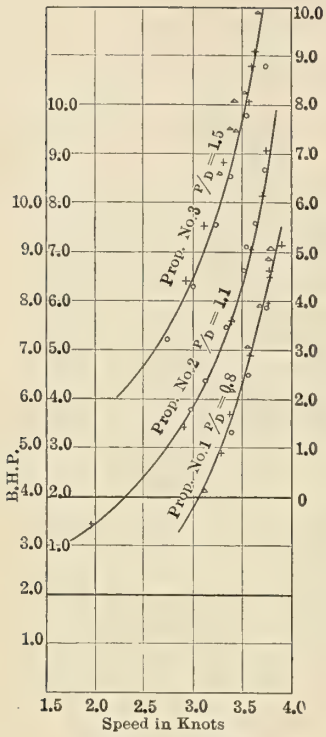

FIG. 5.—TOW RUNS OF FROUDE

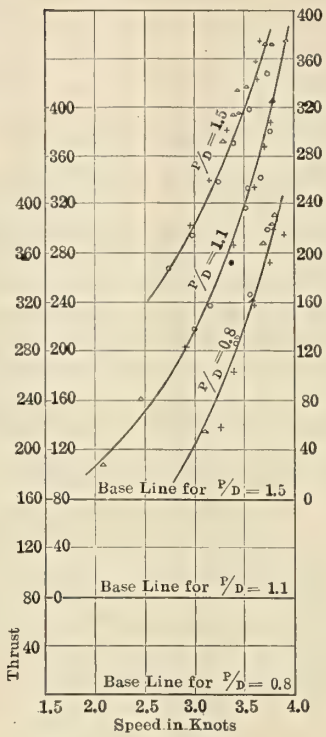

FIG. 6.—TOW RUNS OF FROUDE

This conclusion, if accepted, has a wide importance, because it indicates that the best propellers for towboats have a well-rounded or oval blade and a moderate width. There appears, therefore, to be no reason for retaining the traditional towboat propeller with its excessive area and wide-tipped blades, more especially as *Froude's* recent experiments show that such wide-tipped propellers are about 3 percent less efficient than well-rounded blades.

This separate, preliminary investigation of the effect of blade area (or rather of its ineffectiveness) clears the field and allows us from now on to concentration on other elements which have determining effects.

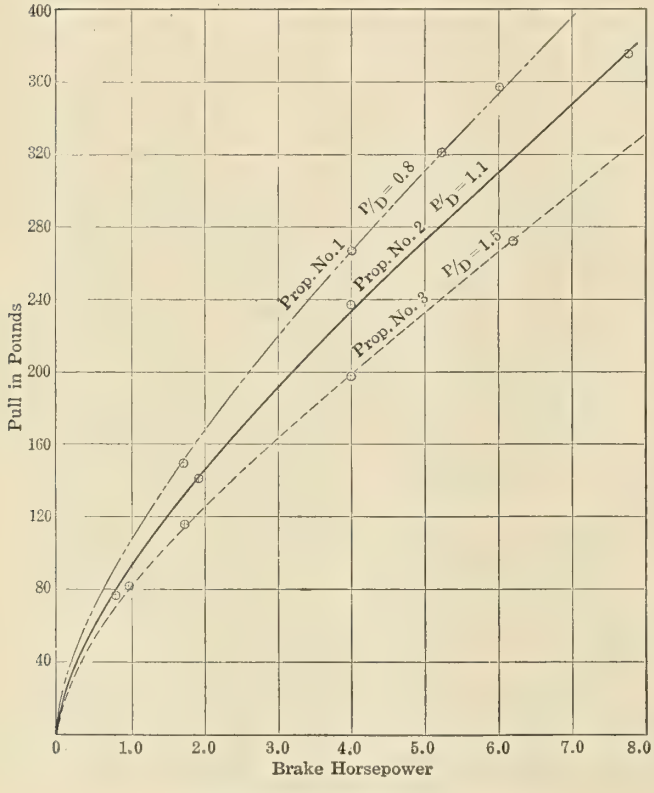

FIG. 7.—CURVES OF PULL ON B. H. P. OF FROUDE

EXPERIMENTS ON THE FULTON, 1912

Three types of experiments were made this year on the *Fulton:* (1) running free; (2) towing at various speeds up to about 0.6 full speed, and (3) pulling, both going ahead and backing. Three propellers were used, all of which had very nearly the same projected contours as the *Sotoyomo* propeller as shown in Fig. 3; the smaller pitch-ratio propellers had somewhat less width fore and aft and less helicoidal area, but since the experiments on the *Froude* showed that area has little or no effect on performance, the variations of helicoidal area of these three propellers need not call for attention.

In order to present the quality of our work and the regularity of results obtained, an individual diagram for each type is given in Figs. 8, 9 and 10, with all the points representing separate experiments as well as with fair curves. Thus Fig. 10

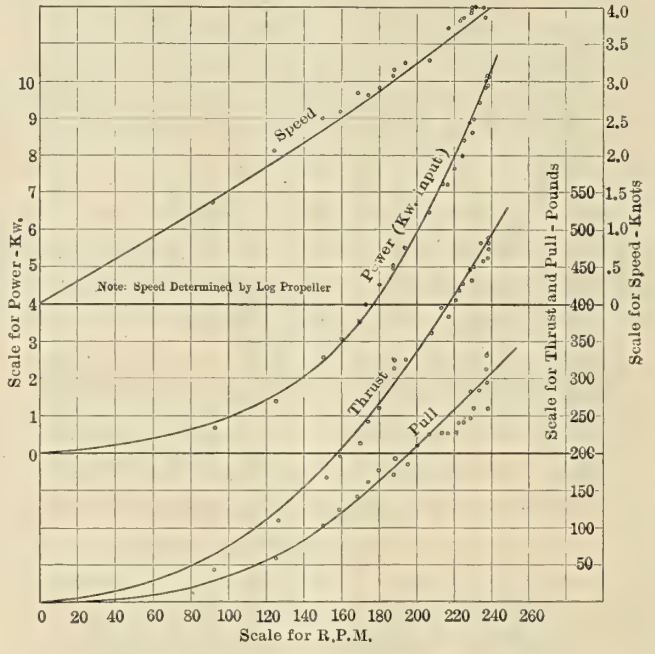

FIG. 8.—TOWING TRIAL OF FULTON. PROPELLER NO. 3, PROPELLER SETTING NORMAL, PITCH RATIO 1.289, LENGTH OF TOW-LINE 80 FEET

shows curves of speed propeller thrust and brake-horsepower, all plotted on revolutions of the propeller. For both speed and thrust there are curves with and against the wind; the power for a given setting of the machinery is not appreciably affected by the wind under the favorable conditions selected for experiment, and only one curve is drawn. On this plate the power is the input to the motor in kilowatts which is afterwards corrected by comparison with our brake tests to given brake-horsepower as used in the other plates. It may be claimed that the regularity and distribution of points for these experiments leave little to be desired, and a comparison with standardization of full-sized ships in a tideway under such weather conditions as may chance to be experienced will lead us to wonder that such tests are as good as they are, rather than that they are not more nearly what we would desire.

Fig. 8 gives for one of our series of towing experiments individual points and curves showing speed, power, propeller thrust and tow-line pull, all plotted on revolutions of the propeller. The curves of thrust and power call for little comment unless we notice that the greater apparent dispersion of points is partly due to the fact that wind had relatively larger effort on account of slower speed.

As was explained in the preliminary statement the speeds

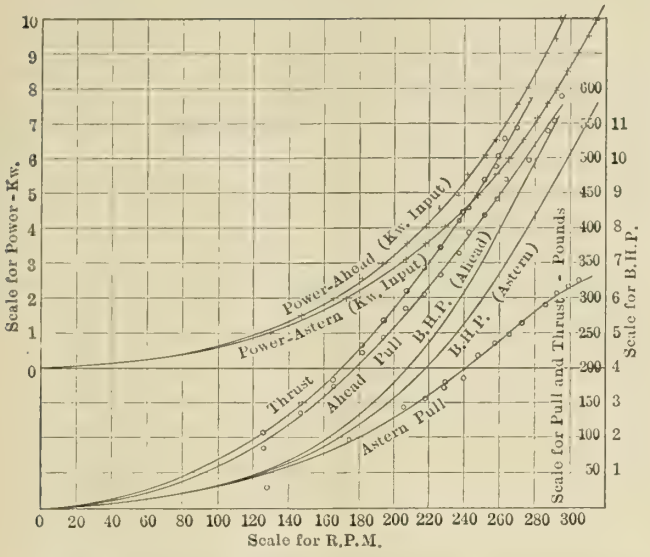

FIG. 9.—PULLING TRIALS OF FULTON. PROPELLER NO. 1, PROPELLER SETTING NORMAL, PITCH RATIO 0.8

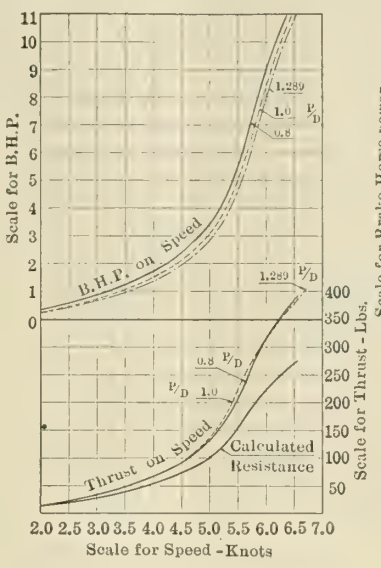

FIG. 11.—RUNNING TRIALS OF FULTON

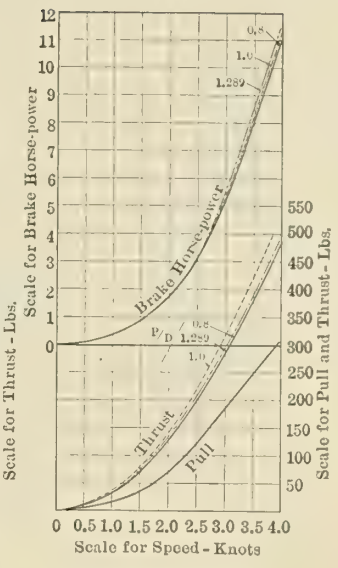

FIG. 12.—TOWING TRIALS OF FULTON

during towing were measured by a little propeller 8 inches in diameter and with 14 inches pitch, which was carried by a bow outrigger so that its axis was 9 inches below the water level and 8 feet in front of the stem of the boat. Though this propeller log showed good results on special runs without a tow over the measured course, its operation during towing was less satisfactory, chiefly because as the season advanced we found it necessary to accept weather conditions less favorable than we would like, trying to minimize wind influence by choosing sheltered parts of the basin. Several runs were made in succession with the wind, followed by others against the wind. In drawing the fair curves greater weight was given to points which our records indicated as more reliable, and especially to points favored by shelter or other weather conditions. If two points which are apparently rather wide from the speed curve, and which we believe to be erratic, are neglected, the dispersion of points indicates that the probable error of speed measurement of a single test may be as large as 4 percent, but we believe that the mean curve is much nearer the truth, and we desire to claim a precision of 2 percent, which, after all, is not unfavorable considering that towing is at low speed. The dispersion of the points showing thrust and pull on tow-line is a direct consequence of the uncertainty of speed.

Fig. 9 shows points and curves of pulling tests with the tow-line secured to a pile of Harvard Bridge. Going ahead the weigh-beam was set up astern, but in backing it was set up near the bow. All these runs were made readily, and in particular there was no indication that the race from the propeller had any tendency to break. Our thrust mechanism did not allow of measurements while backing. It must be admitted that the points and curves leave little to be desired, and that the records can be accepted without reservation.

Certain subsidiary experiments will be reserved for future discussion to avoid confusion.

RUNNING FREE

The performance of towboats of the ocean-going and harbor type may be discerned from Fig. 9.

As was pointed out in last year's paper the propeller with maximum pitch ratio (1.5) as used for towing on the *Froude* had a small clearance from the fair water on the stern post, and consequently it demanded a disproportionate power. This does not affect our discussion of the effect of area ratio, but

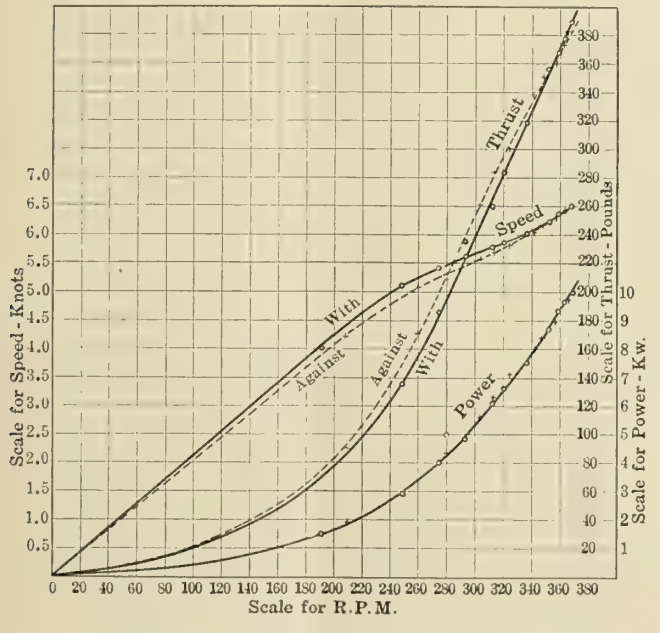

FIG. 10.—STANDARDIZATION TRIAL OF FULTON. PROPELLER NO. 1, PROPELLER SETTING NORMAL, PITCH RATIO 0.8

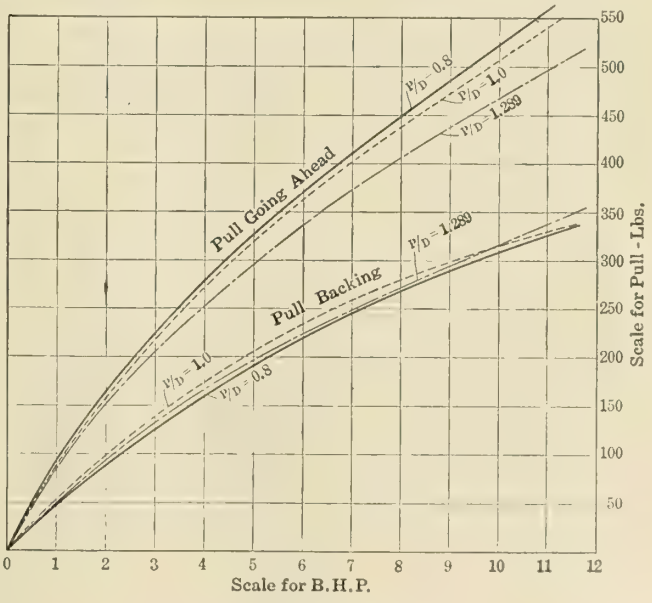

FIG. 13.—PULLING TRIALS OF FULTON

throws it out of line in the discussion of the effect of pitch ratio. Comparing, now, the other two propellers having pitch ratios of 1.1 and 0.8, it appears that at 7 knots speed they required, respectively, 8.3 and 8.5 brake-horsepower; this result may be attributed directly to the poorer efficiency of the low-pitch wheel, with only the reservation that experiments on propellers would lead us to expect a somewhat larger disadvantage.

The running trials on the *Fulton*, shown in Fig. 11, indicate quite clearly the disadvantage of a small pitch ratio which is associated with a poorer propeller efficiency; thus the propellers with pitch ratios of 1.3, 1.0 and 0.8 at 6.5 knots require 10.7, 10.9 and 11.5 brake-horsepower, respectively, or, inverting the comparison, those which with 11 horsepower would

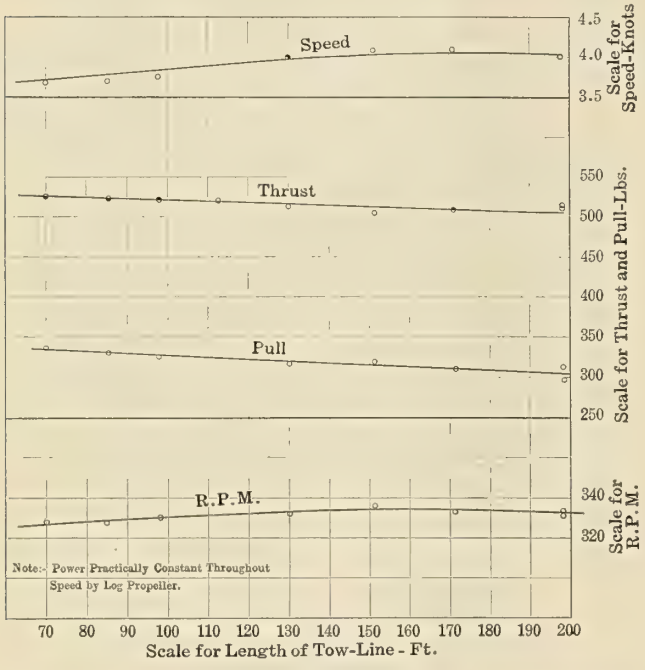

FIG. 14.—TOWING TRIAL OF FULTON. PROPELLER NO. 1, PROPELLER SETTING NORMAL, PITCH RATIO 0.8

give the *Fulton* speeds of 6.55, 6.51 or 6.37 knots. The difference, though not large, might be important in getting a tow away from a competitor.

In the same figure there are shown curves of propeller thrust for the two propellers with lower pitches; for the pitch ratio of 1.3 only the upper end of the curve appears, as the lower part was not properly recorded by our thrust mechanism. These curves are quoted and also the resistance (as determined by the theory of mechanical similitude) from the towing of the *Sotoyomo's* model at Washington.

Towing

The performances of ocean-going and harbor towboats towing at full power and at about 0.6 full speed are shown in Figs. 5 and 12. Fig. 12, which represents results of experiments on the *Fulton*, shows a small advantage for the low-pitch propeller. Fig. 5 shows a corresponding advantage for a propeller of the *Froude* with a pitch ratio of 0.8 as compared with one having the pitch ratio 1.1; the coarse pitch-wheel with a ratio of 1.5 appears to be at a great disadvantage, but I mistrust that this is to be attributed in part to a defective clearance from the stern post, as already indicated; such a pitch ratio is not fitted for an ocean-going tug, and the importance of the comparison is therefore diminished in consequence.

Fig. 12 shows also the propeller thrust and the pull on the tow-rope measured by our weigh beam, which are given as a matter of interest. The curious inversion of order of the thrust curves is yet to be explained.

It is to be noted that runs at less than about 0.6 full speed are with reduced power; they are most interesting experimentally, especially as the sequence of the points allows us to locate the curves certainly. A very important series which we have not attempted to run is to vary the speed at full power by increasing the resistance of the tow. Such a series of experiments, with the time required for adjusting resistance to speed, might profitably occupy a summer's work.

Pulling

The collected results of experiments on pulling against a fixed point with 100 percent slip of the propeller are shown

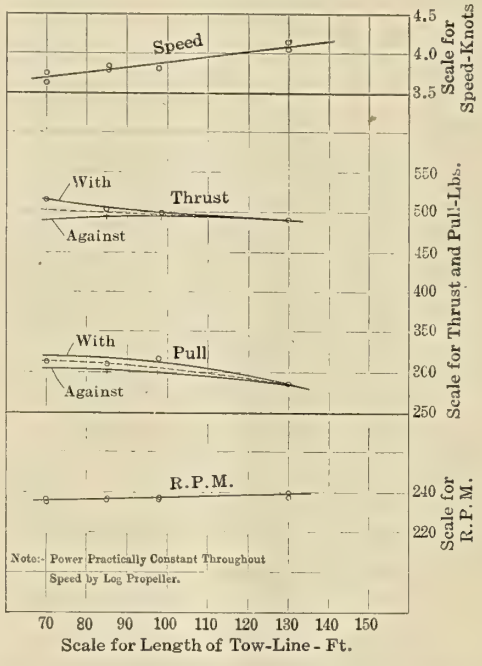

FIG. 15.—TOWING TRIAL OF FULTON. PROPELLER NO. 3, PROPELLER SETTING NORMAL, PITCH RATIO 1.289

by Fig. 7 for the *Froude* and by Fig. 13 for the *Fulton;* the latter was tried pulling both ahead and astern.

On both the *Froude* and the *Fulton* propellers with smaller pitches gave better results pulling ahead. On the *Froude* the advantage of the small-pitch propeller was very striking; thus at 7 brake-horsepower the pulls for the propellers having pitch ratios of 0.8, 1.1 and 1.5 were 400, 350 and 300 pounds. On the *Fulton* the smaller pitch showed an advantage but by no means so notable; thus at 11 brake-horsepower the propellers having the pitch ratios 0.8, 1.0 and 1.3 gave the pulls 560, 545 and 490.

Length of Tow-Line

For all the experiments thus far recorded the length of the tow-line was constant, being 80 feet when the *Froude* was towing and 70 feet for the *Fulton*. In Figs. 14 and 15 results of experiments on the *Fulton* with varying lengths of tow-line are shown. It will be noted that these propellers having pitch ratios of 0.8 and 1.3 gave substantially the same results, as indeed might be expected, since the question under consideration is the effect of the race of the propeller on the resistance of the tow.

The most interesting feature of these results is the effect of length of line on speed; the changes being small are to some extent covered up by the lack of accuracy of our bow-log for measuring speed; nevertheless, there appears to be a substantial advantage from use of a long line which is best brought out in Fig. 14. Bearing in mind that the *Fulton* is 30 feet

long there is a gain of about 10 percent in speed due to lengthening the line from twice the length of the towboat to six and a half times the length. In this comparison the pull on the tow-line gives the most positive indication of the advantage of a long line; this confirms the result just quoted in terms of speed, as the pull diminishes about 10 percent.

Towing Abreast

In a seaway ships and barges are always towed with considerable length of line for obvious reasons; in smooth, restricted waters the towboat is commonly brought alongside. In Fig. 16 curves are shown with the *Fulton* towing with an 80-foot line (less than three times its length), and towing abreast. There is an advantage of 10 to 12 percent when towing abreast, which is about the advantage of using a long

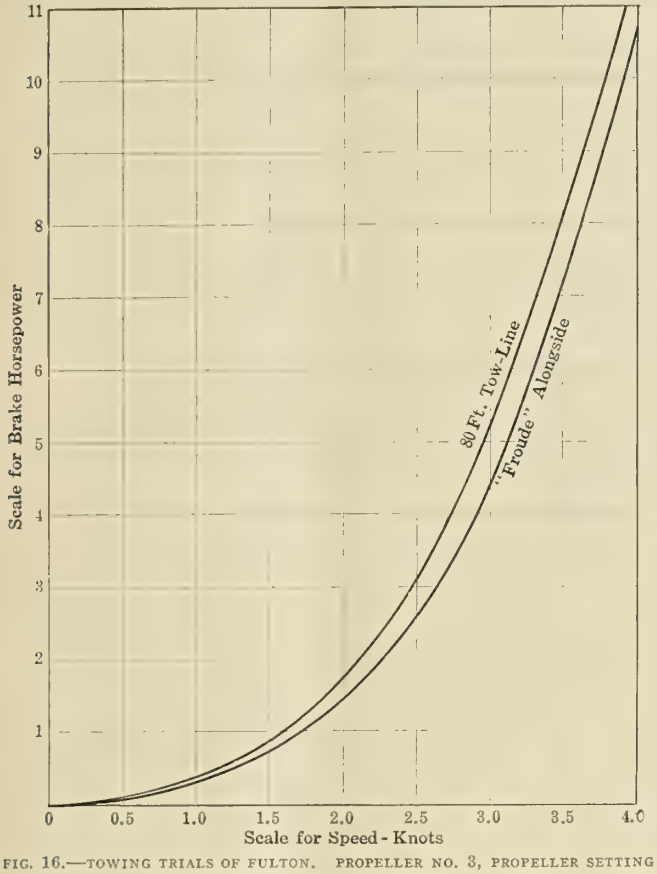

FIG. 16.—TOWING TRIALS OF FULTON. PROPELLER NO. 3, PROPELLER SETTING NORMAL, PITCH RATIO 1.289

tow-line (six or seven lengths). The common practice of either using a long line or towing abreast appears to be well founded.

Designing

The most practical use that can be made of the results of these tests on towing is for the design of new boats. Fortunately both the *Manning* and the *Sotoyomo* are well designed, having good form and fair lines. Perhaps the *Manning* is a little too fine for an ocean towboat, which is likely to be rather shorter and more beamy; the form of the *Sotoyomo* appears to be exceptionally good for speed, and might well be taken as a type for design except where speed is of minor importance, in which case a fuller body might enable a boat to carry more power.

It may therefore be suggested that designs for towboats shall be based directly on the tests of the *Froude* and the *Fulton* by the theory of mechanical similitude, bearing in mind that the experiments were all made in fresh water. The usual method of assuming resistance and power to be proportional to the density can be used in applying our results to boats operating on salt water.

Our results are given in brake-horsepower, while engines are habitually designed for indicated power. My own opinion is that a mechanical efficiency of 0.90 may be obtained for a well-built engine when in good condition; 0.85 may be shown by those who wish to be conservative.

The curves shown herewith show that towboats are likely to be driven well up to the critical speed at which the power increases more rapidly than the cube of the speed; consequently the common method of using an Admiralty coefficient for estimating power is, in my opinion, entirely inapplicable.

The speed for towing (about 0.6 full speed) is well under the critical speeds, and our experiments show that power varies nearly as the cube of the speed, and consequently the method of the Admiralty coefficient may properly be used.

It is therefore proposed that tow-boats shall be powered for towing at a speed-length ratio of 0.6 to 0.7 by the equation

$$I.\,H.\,P. = \frac{D^{2/3}\,V^3}{K\,L},$$

where D is the displacement in tons (2,240 pounds), V is the speed in knots, and L is the length on waterline in feet, while K is the Admiralty coefficient. The speed-length ratio is computed by the form

$$\frac{V}{\sqrt{L}}.$$

The speed-length ratio of the *Froude* when towing at 3¾ knots was 0.6, and the Admiralty coefficient corresponding is 21. The *Fulton* when towing at 3¾ knots had a speed-length ratio of 6.7, and for it the Admiralty coefficient is 22.5.

Having determined the power for towing at a given speed, the speed running free may be investigated, or we may simply accept what we get; especially at or near the critical speed it takes a large increase in power to affect the speed appreciably.

To complete the design requires the determination of the proper size and proportions of the propeller. Through the courtesy of the chief constructor, Admiral R. M. Watt, U. S. N., tests of models of our propellers for the *Fulton* have been made with large slips required for towing by Naval Constructor Taylor. From these tests and from our own data on thrust I hope to be able to present an analysis of this matter at some future time.

Launch of the Washington Irving

The New York Shipbuilding Company, Camden, N. J., launched, Dec. 7, the Hudson River steamboat *Washington Irving*, built for the Hudson River Day Steamboat Company, New York, and to be used in the New York City and Albany service. The vessel has a length over all of 416 feet 6 inches; a beam over all of 86 feet 6 inches; beam, molded, 47 feet; depth, 14 feet 16 inches; draft, 7 feet 4 inches. She is propelled by side paddle-wheels 24 feet 6 inches in diameter, each wheel having nine steel buckets, 15 feet long by 4 feet 3 inches wide, driven by a three-cylinder, compound, inclined, direct-acting engine, developing 6,000 horsepower. Steam is supplied by four single-ended and two double-ended Scotch boilers, carrying a working pressure of 170 pounds per square inch, working under Howden's forced draft system. The machinery was contracted for by W. & A. Fletcher Company, of Hoboken, N. J. The vessel was designed by J. W. Millard & Bro. and Frank E. Kirby, of New York. The former firm is well known as the designer of the municipal ferryboats and other harbor craft in New York, and the latter as the designer of the largest passenger steamers on the Great Lakes. These naval architects also collaborated in the design of the *Hendrick Hudson* and the *Robert Fulton*, of the Hudson River Day Line. The *Washington Irving* is destined for exclusive day passenger service, and has an available deck area for passenger use of 66,564 square feet, which will provide for 1,400 more passengers than the 6,000 called for in the vessel's certificate.

Recent Developments in Oil Fuel Burning

BY E. H. PEABODY

With the continued increase in oil production the use of this ideal fuel is rapidly extending, particularly for marine purposes, and it seems worth while therefore to point out some of the main characteristics of the mechanical atomizer and modern methods of handling it. In attempting this the writer will of necessity have to look at the subject from his own point of view, and in the light of his own experience and the experiments carried out by the Babcock & Wilcox Company.

Atomization vs. Gasification

To begin with, Commodore Isherwood's conclusions of some forty years ago hold good to-day, namely, that atomization of the oil, as distinguished from vaporization or gasification in the burner, "is the only method that has been attended with success." There are not wanting those who still claim advantage for those forms of apparatus which, by various methods of treatment of the oil, admit the fuel to the furnace in the form of vapor. These systems, while successful in metallurgical work, have no standing in boiler practice, for the reason that they show no gain in efficiency, but, on the contrary, result in very poor capacity, the latter feature alone

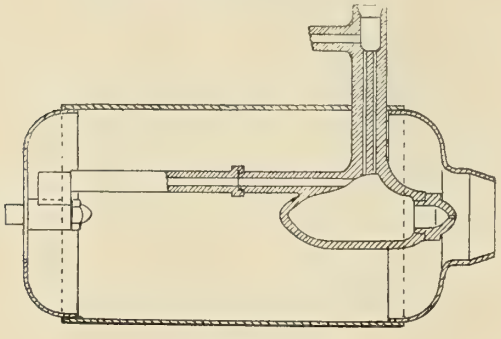

FIG. 1.—DÜRR BURNER

making them undesirable for marine use. At the same time some of these devices are ingenious and interesting, and I have taken as an illustration of the vaporizing type of burner an apparatus patented in England in 1907 by Mr. L. Dürr (Fig. 1). There are two burners in the form of retorts, a big one and a little one, the idea being that the little burner by playing a flame on the outside of the big burner will gasify the oil for the big burner and for itself as well. Several patents followed this one, each correcting some shortcoming of the preceding.

The well-known Köerting process patent, taken out in this country in 1905, contains a claim which covers heating the liquid oil unmixed with air or other gases to a point above its normal boiling point, maintaining the oil in a liquid state by pressure and delivering the superheated oil into a combustion chamber supplied with air, whereby the rapid disintegration and vaporization of oil in the presence of air are secured.

The idea here, as is more fully pointed out in the patent specifications, is that the heat stored in the oil at high-pressure will cause the liquid to flash into vapor when released at low-pressure, exactly as water, heated above 212 degrees F. under pressure, would flash into steam if released to the atmosphere. This is an exceedingly ingenious way of converting at least part of the oil into vapor without atomizing it, but as a matter of fact no gain results from this partial gasifying of the oil. This question has been tested out experimentally, and, what is more to the point, nobody is doing it, not even the users of the Köerting apparatus itself. The dangerous expedient, therefore, of heating oil above its flash point at atmospheric pressure is not found necessary.

Effect of Heating Oil on Viscosity

The real value of heating the oil is rather a mechanical one, namely, to reduce the viscosity of the liquid so that it can be forced through the small passages of the burner and given a rapid whirling effect, sufficient in the more limpid condition of the oil to reduce it to a fine spray through the action of centrifugal force when liberated from the tip.

It will be found from a study of fuel oils that, while the viscosity is tremendously affected by changes in temperature at the lower ranges, very little difference in viscosity results with heating or cooling as the temperatures approach the flash point.

With all ordinary oils it may be considered that heating within 50 degrees F. of the flash point will be sufficient to render the oil suitable for use with the mechanical burner, and in the case of many of the lighter oils even this heating

FIG. 2.—SCHÜTTE SPRAYER

is unnecessary, the oil being sufficiently limpid at ordinary atmospheric temperatures.

Mechanical Spraying

Several methods of spraying oil by mechanical means have been suggested, such as forcing the liquid through a very fine aperture, forcing a jet of oil at high velocity against some object or against another oil jet, throwing the oil off from a rapidly revolving table or disk, or giving the liquid itself a whirling motion and reducing it to spray by centrifugal force.

In 1902 the writer tried the first idea and succeeded in making a very poor flat-flame mechanical atomizer by forcing the oil between two flat surfaces pressed closely together, and in 1907, when in answer to the navy's call we took up the matter of mechanical atomizing seriously, we tried some of the other schemes. The experiment of making two round jets of oil strike each other on the principle of the acetylene burner, resulted very interestingly in a flat spray—not fine enough, however, with heavy oils to be practicable. A mechanical atomizer, or, as it was called, a "self-atomizer," consisting of eight small jets meeting at a central point, was patented in England in 1904 by Mr. Charles Ferdinand de Kierskowski Steuart. It is a good example of spraying by forcing jets of oil to strike each other, but otherwise has attained no importance in the art.

The only method of atomizing fuel oil mechanically which has attained any practical success is that wherein the oil is given a whirling motion inside the burner tip. There are two distinct means for doing this—first, by forcing the oil through a passage of helical form, like a screw thread, and, second, by delivering the oil tangentially to a circular chamber from which there is a central outlet.

As an illustration of the first form I have selected the "spraying nozzle" patented in the United States in 1895 by Mr. L. Schütte. This is shown in Fig. 2. Judging by the patent, the inventor had principally in mind, with regard to this particular apparatus, the spraying of water, but the device

* A paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1912.

is an excellent example of the use of the helical passage for giving the liquid a whirling motion.

Another adaptation of the same idea is shown in a patent taken out in England in 1899 by Mr. James Howden (Fig. 3).

He refers to heating the oil by means of live or exhaust steam or the waste gases, pumping it into an accumulator or air receiver for neutralizing the pulsations of the pump, and

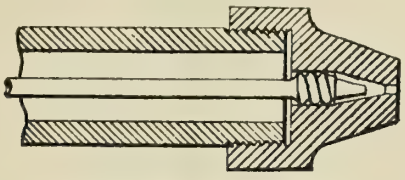

FIG. 3.—NOZZLE OF HOWDEN BURNER

then projecting the oil into the furnace in the form of fine jets or spray by passing it through a nozzle which he describes as having helical grooves on a part of the spindle within the nozzle, so as to impart a whirling motion to the oil. Howden's burner is adjustable in that the taper spindle moves "up and down" in the taper passage leading to the nozzle orifice. This movement of the spindle increases or decreases the area of the outlet passage, thus controlling the amount of oil delivered by the burner, but the helical passage is not affected. The single claim of the patent covers the combination of the adjustable nozzle "encircled by an adjustable annular opening

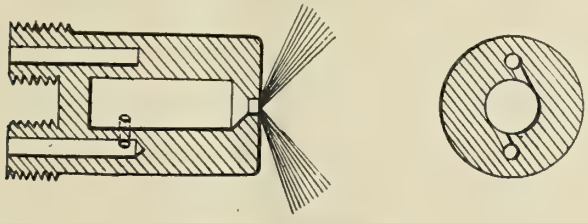

FIG. 4.—JONES BURNER

through which the air for combustion, supplied by a fan or blower and heated by the waste gases from the boiler, issues and mixes with the oil jets as they enter the furnace."

Howden does not claim the atomizer, and its similarity to the Schütte-Köerting burner shown in Fig. 33 is suggestive. The Schütte-Köerting burner, however, is not adjustable.

The idea of delivering the oil tangentially to a chamber inside the nozzle is shown in a burner patented in England by Mr. Albert Edward Jones in 1907 (Fig. 4). This invention, as a matter of fact, contemplates the use of a gas or vapor in

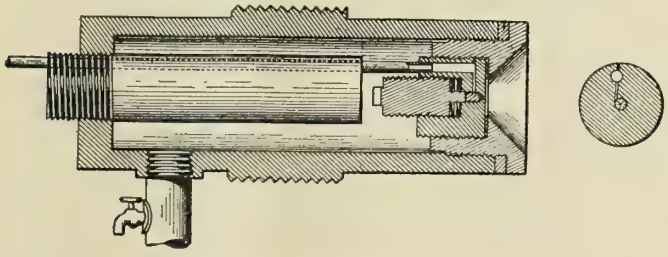

FIG. 5.—STRINGHAM-ELMENDORF NEBULIZER

combination with a combustible liquid, and is not strictly what we consider a mechanical atomizer, but the device is almost a diagrammatic illustration of the tangential principle, and for that reason I have reproduced it here. It may be considered that oil is forced into both tangential passages, or that only one is used, this depending only on the whirling motion of the oil to cause the spraying.

A so-called "nebulizer of the heavier hydrocarbons," patented in this country in 1908 by Stringham and Elmendorf, is a good illustration of the further development of the tangential principle, and is shown in Fig. 5. This apparatus was water-cooled, a precaution not found necessary in connection with boiler furnaces.

Modification or combinations of the tangential and helical forms of burners are frequently encountered in the art, and an illustration of one of these is shown in Fig. 6. This is an ingenious burner patented in England by Sir John Thornycroft in 1906, in which it will be noted that the oil passages within the tip are made variable in area of cross-section by an adjustment of the spindle, thus varying the quantity of oil delivered without alteration of either oil pressure or size of outlet passage. This renders the burner adjustable like the

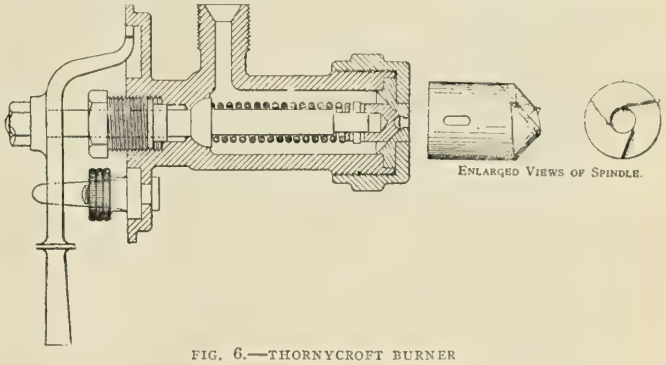

FIG. 6.—THORNYCROFT BURNER

Howden, though by a different process, in that in the Howden burner the helical passages remain unaltered and only the outlet orifice is changed.

CONTROL OF CAPACITY

This matter of adjustability of an oil burner; that is, the ability to change the quantity of oil delivered in a given time without changing the oil pressure or the velocity of the liquid through the tip, while attractive in idea, and perhaps well sustained in theory, has no particular value in practice. It is a fact that the simpler forms of burners which do not possess this feature are quite, if not more, successful in regular operation on shipboard. The manipulation of the oil pressure acting on all burners at once presents in itself a simple means for the control of output through a wide range; a good burner will atomize moderately heavy oil with an oil pressure as low as 30 pounds, and from that up to 200 or above. If this range is insufficient to meet the variable steam requirements, then it is easier and better to shut down a portion of the burners entirely than to attempt to adjust each individual burner separately, particularly as it is important to regulate the quantity of air for combustion admitted to the furnace at the same time the quantity of oil is varied. This air supply can easily be controlled for all burners by regulating the draft pressure, and the air can be closed off entirely when a burner is shut down. This puts the question of proper air supply more into the hands of the designer, requiring the operator to determine only the proper conditions of draft pressure for the plant as a whole at the required capacity.

EFFECT ON CAPACITY OF HEATING OIL

Another means of varying the quantity of oil delivered by all burners in addition to alteration of oil pressure is available in alteration of oil temperature. Generally speaking, under working conditions any increase in temperature of the oil results in decreased capacity of the burners, the pressure remaining the same. The reverse is the case at low temperatures, the critical point depending on the relationship between viscosity and specific volume of the oil in question. This law is shown graphically in the diagram in Fig. 7, giving the results of a test on a sample of Texas oil of 18 "gravity" (degrees Baume) and a flash point of 240 degrees F. The oil

pressure maintained constant throughout the test at 200 pounds, and the temperature was raised by stages from 80 degrees F. to the flash point. The burner capacity increased rapidly up to a temperature of 110 degrees, where it reached a maximum. With continued heating it began to fall off, and continued to do so throughout the range of the experiment.

Requirements of Mechanical Burner

It will be obvious, if oil is to be atomized by centrifugal force, that the best spray will be obtained by giving the oil the maximum whirling motion and reducing to a minimum the

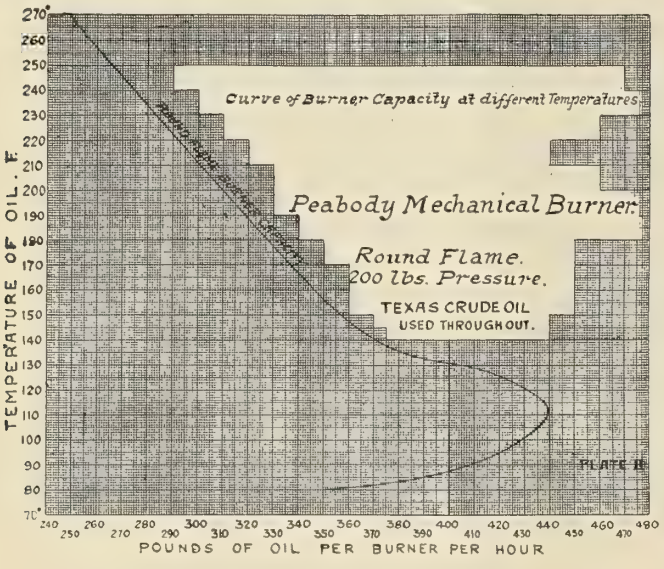

FIG. 7.—TEMPERATURE CAPACITY CHART

friction in the burner, so that the whirling motion once obtained shall not be diminished before the oil is liberated. These are axiomatic principles, recognized by all, and no doubt each inventor believes he has best met the requirements.

It seems to me that the tests are these—that these are the controlling factors in the "survival of the fittest":

1. How heavy an oil will a burner thoroughly atomize?
2. What pressure and temperature are necessary?
3. What degree of simplicity has been attained in the design?

Use of Heavy Oil

I might say here that any apparatus which will not handle heavy oil will have a very limited usefulness. Already the market is beginning to be supplied with very heavy oils from Mexico; there is considerable crude oil in California below 15 degrees gravity, and the tendency will be more and more to use the heavier residuums. I believe that in a few years we will be using oils of 12 degrees to 15 degrees Baume as commonly as we are consuming oil of 27 and 30 degrees gravity to-day.

The Babcock & Wilcox Company recently received from the Texas Company, for experimental purposes, some Mexican crude oil, having the following characteristics:

Specific gravity at 60 deg. F.	.981
Degrees Baume at 60 deg. F.	12.6
Moisture and silt	3.5
Flash-point	310
Burning point	347
B. T. U. per pound (oil as received)	17,551

In appearance this oil was black, and at temperatures of about 80 degrees very sticky and viscous. On heating to 212 degrees it turned to foam owing to the presence of so much water, and this failed to separate out, a sample of the oil being thinned down with ether to determine the percentage. Ordinary settling tanks would have been practically useless, as the oil was so near the specific gravity of water. This oil was, however, successfully sprayed and burned under natural draft on being heated to 270 degrees at a pressure of 165 pounds. A slight amount of smoke was formed, which disappeared on a slight increase in the furnace draft above twelve-hundredths inch of water. The most noteworthy feature of the experiment was that the capacity fell off about 40 percent from that obtained with the same apparatus with oil of 18 gravity.

This sample of oil was the worst the writer has ever seen, but they say there is more of it, and it is a specimen of what we may have to handle in the near future.

DENSITY OF OIL

Degrees Baume.	Specific Gravity.	Pounds per Gallon.
12	.986	8.22
14	.973	8.11
16	.960	8.00
18	.948	7.90
20	.936	7.80
22	.924	7.70
24	.913	7.61
26	.901	7.51
28	.890	7.42
30	.880	7.33
32	.869	7.24

The above table of densities is given for convenient reference.

Peabody Mechanical Atomizer

In the light of our experiments, begun in 1907, we have come to believe that the best rotative effect on the oil is produced by the tangential delivery method, and it seems plain that the best way to reduce friction is to reduce the amount of surface to which the oil is exposed in its travel through the burner after it begins to whirl and until its exit from the tip. We have also come to attach great importance to simplicity in everything connected with oil burning, and we believe that the oil burner itself should be of simple construction, easily taken apart, and so designed that when taken apart all the small passages and wearing surfaces will be exposed for inspection, cleaning and repair.

The results of the writer's efforts to construct a burner to meet these requirements are shown in Fig. 9. Oil is delivered under pressure to an annular channel cut into the face of a

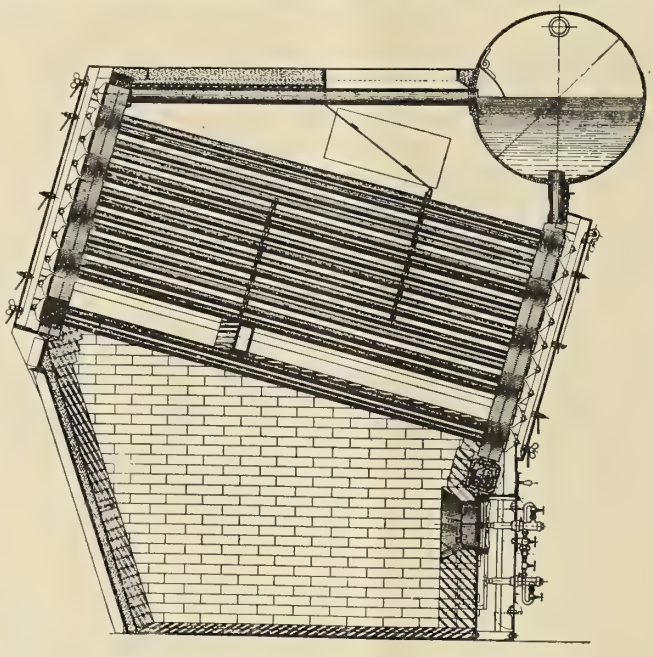

FIG. 8.—FURNACE OF BABCOCK & WILCOX BOILER

nozzle upon which is screwed a tip having a very small central chamber communicating with a discharge orifice. Between the nozzle and the tip a thin washer or disk is inserted and held firmly in place. This has a hole in the center corresponding with the diameter of the central chamber of the tip, and small slots or ducts, extending tangentially from the edges of the

central opening outward toward the periphery of the washer, long enough to overlap the annular channel of the nozzle and put it in communication with the central chamber. The effect is that when the burner is assembled with the washer in place, oil is delivered through the ducts tangentially to the

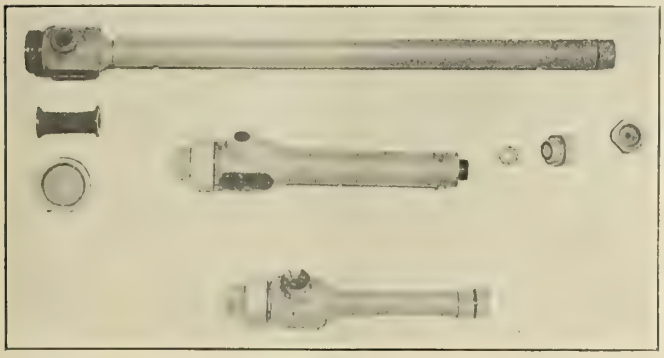

FIG. 9.—PEABODY MECHANICAL ATOMIZER

central chamber, where it rapidly revolves and almost immediately is discharged through the orifice in the tip.

Character of Mechanical Spray and Effect on Combustion

In order to correct a popular fallacy I beg to call attention here to the fact that no mechanical atomizer produces a re-

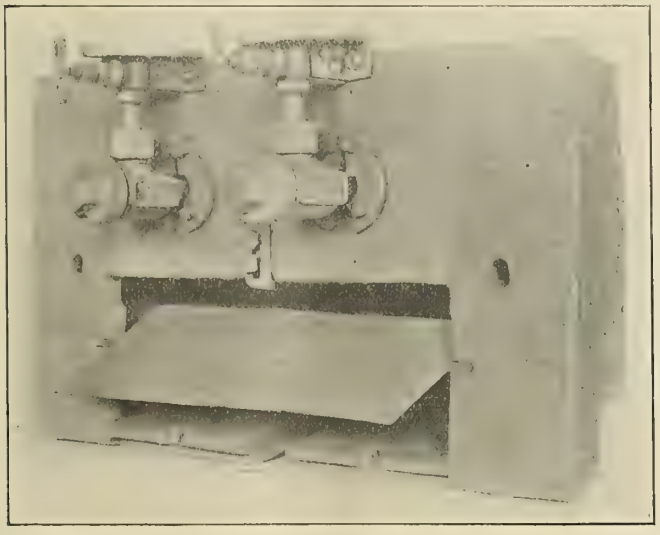

FIG. 10.—FITTING OF OIL BURNERS FOR COAL AND OIL FRONT

volving spray, but the particles of oil fly off in straight lines under the influence of centrifugal force, thus forming a hollow, conical spray. The fineness of this spray, *i. e.*, the minuteness of the particles forming it, has a most important bearing on the results obtained in the furnace. It is possible with some forms of steam atomizers to atomize oil so finely that no flame at all will be produced, the incandescent combustion chamber being filled merely with a clear, invisible gas and every brick being discernible. I doubt if this condition of flameless combustion can be produced with mechanical atomizers and heavy oil, nor is it desirable under any circumstances, for the simple reason that it costs too much.

With the production of flame, however, furnace design assumes an added importance, for the flame must be distributed evenly and without localizing on the heating surfaces of the boiler, and the gases must be given time and space in which to expand and burn as nearly as possible to completion before being cooled and the flame extinguished by contact with the tubes of the boiler. These points become exceedingly vital when the boiler is forced to the requirements now demanded in naval service.

Furnace Design

Having an atomizer, therefore, that will produce a fine spray with heavy oil, and which is simple, reliable and easily handled, the problem becomes one, not of oil burner, but of furnace design and air distribution. Our work has been carried on, until recently, entirely with the Babcock & Wilcox marine boiler, a design having a furnace ideally suited for any volatile fuel, and particularly for oil. A longitudinal section through this boiler fitted with mechanical atomizers is shown in Fig. 8. It will be seen that the characteristics of this furnace are: Large volume in proportion to the heating surface of the boiler; upward slope of the roof toward the rear, resulting in increase in height and volume in the direction of the entering oil spray, and thus providing room for the expansion and diffusion of the gases; small amount of boiler heating surface exposed, and, on the contrary, large exposed surface of incandescent refractory material, thus tending to maintain high furnace temperature and promote complete and rapid combustion of the oil; tubes almost parallel with path of the oil spray injected into the furnace from the front, thus promoting proper distribution of the gases along the tubes and preventing local overheating; outlet from the furnace at the point most remote from the location of the atomizers, thus insuring long travel of the gases, and, finally, means for bringing the heated products of combustion into the closest possible contact with the entire amount of heating surface of the boiler, discharging the waste gases into the up-take at temperatures but little above that of the steam generated. These conditions combined to relieve us of any worry about furnace design, or, to put it another way, we had been through all that before with steam atomizers.

Our experiments therefore developed principally into a search for the best method for admitting the air for combustion. *(To be continued.)*

Voyage of the Motor Ship Eavestone.—The Diesel-engined motor ship *Eavestone,* built recently by Messrs. Sir Raylton Dixon & Company, Middlesbrough, and engined by Messrs. Richardson, Westgarth & Company, Ltd., Middlesbrough, in conjunction with Messrs. Carels Bros., Ltd., Ghent, Belgium, has just completed a voyage of 3,701 nautical miles from Pomaron to Savannah, Ga., without a single stop. The steaming time was 18 days 18 hours 14 minutes, the average speed 8.2 knots and the average daily fuel consumption 3 tons 18 cwt. The total oil fuel consumed for the voyage was 73 tons 10 cwt. This vessel was fully described on page 405 of the October, 1912, issue of International Marine Engineering. Since she went into commission, however, a tank has been installed for compressed air from which the steering engine is driven while at sea. This installation has reduced the daily coal consumption for auxiliary purposes from 2 tons to less than 1 ton. The supply of air from the tank can hardly keep the steering engine going when the vessel is maneuvering in and out of port, but as soon as the vessel is placed on her course in the open sea the air tank furnishes ample power for steering the ship.

Monthly Shipbuilding Returns.—The Bureau of Navigation reports 88 sailing, steam and unrigged vessels of 32,879 gross tons built in the United States and officially numbered during the month of November, 1912. Eight steel steamships, aggregating 17,928 gross tons, were built on the Atlantic and Gulf coasts, and one steel steamship of 2,549 gross tons was built on the Great Lakes. The largest vessels completed in this month were the *Dakotan,* of 6,657 gross tons, built by the the Maryland Steel Company, Sparrows Point, Md., for the American-Hawaiian Steamship Company, and the *Lenape,* of 5,179 gross tons, built by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., for the Clyde Steamship Company.

McAndrew's Floating School

BY CAPTAIN C. A. McALLISTER*

CHAPTER III

Force, Work and Power

"Come on, boys, let's turn to and get right at this business," said McAndrew to his class, as they assembled on the following night. "The first part of this course is going to be what you all need the most—a little instruction in elementary principles. There is no good of a man trying to put a roof on his house until he has at least a pretty fair foundation under it. As I have already told you, I don't want to go into any 'high-brow' theories with you, as both of us would be losing something valuable—I'd lose my time and you would lose your interest.

"In all branches of engineering the principal output is power in one form or another. Now, it is a safe bet that none of you knows exactly what power is. I want to get the right idea of it firmly impressed on your memory, so that you will not be like a certain Irishman I know of who, through political influence, got a job to run a small steam engine in the Capitol. A sightseer stopped to look at his engine one day, and asked the son of Erin what horsepower it was. 'Horse-power!' he ejaculated, 'horsepower be ——; don't you see that it runs be stame.'

"Now to understand what constitutes power you must consider three elements—force, distance and time. For instance, here is a block of iron which weighs 5 pounds. I lift it up 1 foot from the deck by using *force* to overcome its weight, and in so doing I have performed *work,* which is measured in what is known as foot-pounds; that is, I have performed 5 foot-pounds of work by overcoming the weight of this 5-pound block through a *distance* of 1 foot. Now get that fixed in your mind, *force* is overcoming weight, and *work* is overcoming weight through distance or space. Now it wouldn't make any difference whether I lifted that 5-pound weight a foot high in a second or ten minutes so far as the term 'work' is concerned, but when you come to 'power' then there is another thing to be considered, and that is the *time* it takes to perform the work. In measuring anything you must have a standard upon which to base your measurements; thus you buy waste by the pound, oil by the gallon, etc., so the early engineers in looking for a standard on which to measure power quite naturally selected the horse, that faithful beast which carries or pulls all manner of burdens for mankind. As a result of experiments on a large number of horses in England many years ago, it was decided that at an average a horse could perform 33,000 foot-pounds of work in one minute; hence this was fixed as the now almost universally adopted standard 'horsepower' for all engines. Always keep in mind, therefore, that power consists of three things—force, distance and time. Later on I'll show you how to calculate the horsepower of an engine.

"The next foundation stone I want you to lay is to get the right idea of the so-called mechanical powers. Only the other day I heard Nelson say when he was working that small jack-screw, 'Gee! but this is a powerful little beggar.' Don't forget one thing right at the start; there never has been any kind of a machine invented where you can get more *power* out of it than you put in it. In fact, it is always a little less on account of the loss by friction. If that jack-screw appeared to lift a weight of several tons with comparative ease, you must remember that it only lifted it a few inches, while your hand traveled a good many feet in working the bar. The fundamental principle of all the mechanical powers is that the weight, multiplied by the distance it moves through, is always equal to the force multiplied by the distance it moves through. Suppose we take this foot-rule and put it over a knife-edge on the 4-inch mark. On the short end we will put these two 1-inch nuts and on the long end we will put one such nut, and you see that they balance exactly. Why? Simply because $2 \times 4 = 1 \times 8 = 8$. That is the principle of the lever, and later on you will find that it is the principle of the lever safety valve about which you will have to know before you can ever get your 'ticket' from the steamboat inspector.

"The next thing you want to understand is the inclined plane. Suppose you want to put a barrel of oil on a truck. You can't lift it off the deck, so you go and get a plank, and, single-handed, you can roll it up and put it in the truck. How could you do it? Simply because you couldn't lift it bodily a distance of perhaps 3 feet you rolled it up a plank 10 feet long. In that manner, while the barrel was lifted vertically 3 feet, you were shoving it for a distance of 10 feet.

"A wedge is simply a double inclined plane; to open up a space ½ inch wide in a plank you often have to drive the wedge lengthwise eight or ten times that distance.

"The screw, such as that jack I was speaking of, is a combination of the lever and the inclined plane. When you take hold of the end of the bar and pull, it acts as a lever on the head of the jack-screw. The thread is simply an inclined plane wrapped around the bolt. Between the two you can exert a tremendous pressure to lift anything, but always remember the great number of times you have to pull that bar around, and compare the distance your hand travels with the short distance the weight is lifted, then the 'tremendous pressure' exerted won't seem to be so mysterious.

"There are several other so-called mechanical powers, but they are all practically based on the principles of the lever and the inclined plane.

"No matter what tool or mechanical contrivance you are using, just try to reason out on the principles I have given you to-night how you are accomplishing the work. To-day, O'Rourke, when you were lifting that main-bearing cap, you know that you couldn't budge it alone, but you had no trouble in hoisting it up with the chain tackle. How do you account for that?"

O'Rourke scratched his head a bit and said, "Come to think of it I guess I did pull that chain about a mile before I got the cap up a foot; the next time I'll let the Dutchman 'hist' her up, while I take observations on how far he has to pull it."

"I see," said McAndrew, "that you'll make good as a scientist, as the first thing any of them learn is to let some other fellow do the manual labor."

CHAPTER IV

Heat, Combustion and the Generation of Steam

"Having told you something about mechanical powers, I now propose to continue still further my remarks on elementary principles, and will take up the subjects of heat, steam, combustion, etc. In starting off I will ask you what is steam?" As no one else seemed to volunteer an answer, O'Rourke blurted out, "It's a white gas that kills you if you breathe it."

"It will kill you all right, but please remember that steam

* Engineer-in-Chief, U. S. Revenue Cutter Service.

is not white until it is condensed into small particles of water —when it is formed in a boiler it is as colorless and invisible as the air. I am afraid, however, that your idea of steam is somewhat cloudy. Of course, you all know that when you shovel coal in a furnace, and boil the water in the boiler, steam is formed; but how? is the question.

"Heat, scientific men inform us, is a mode of motion. All substances are composed of infinitesimal small particles called molecules. Heat is the violent motion of these molecules, and may be occasioned in two fundamental ways. The first is what may be termed chemical action or combustion, and that is what interests us most. The element known as carbon, of which coal is largely composed, unites with another element known as oxygen, and heat is generated. Thus we put coal containing carbon in a furnace and admit air containing oxygen through the grate bars, and heat results from the chemical union of the two elements. They must unite in certain proportions, so that is the reason you have to regulate the dampers and ash-pit doors. The right proportion is one part of carbon and two parts of oxygen. Always remember that the air is just as essential in forming heat as is the coal."

"The air is much easier shoveling," broke in O'Rourke. Not paying any attention to the interruption, McAndrew continued: "The right kind of a fireman is the one who pays attention to his fires and allows the proper mixture of air to reach the fires. If you put in too much coal, such as the 'crown-sheeters,' which O'Rourke likes to carry, the air does not have sufficient chance to circulate through the hot coals to make good combustion. If the clinkers and ashes are allowed to collect on the grates, they also shut off the proper amount of air and your fires get dead. Hence the best way to make steam is to carry a fire of uniform thickness, not more than 6 to 8 inches deep, and by means of the slice-bars keep the ashes off the grates as much as possible. Another thing is to keep your doors shut as much as you can; too much air is as bad as too little. When you have to throw in coal do it quickly, and spread it evenly over the fires. If the conditions are such that there is one part of the oxygen to one of carbon, you will not make much steam, as such a mixture does not burn—simply smells bad.

"As I told you before, there is a method of measuring everything by comparing it with some standard. This applies to heat as much as it does to coal itself, only you do not measure heat by its weight, as it has none; therefore we must measure it by its effect. One of the effects of applying heat to metals is to cause them to expand or grow larger. Taking advantage of this quality the thermometer was invented, which records the expension and contraction of mercury in a glass tube as heat is applied. While the thermometer measures the degree of the heat in a relative manner it does not measure the amount. Hence a unit amount of heat was decided to be the amount necessary to raise 1 pound of water 1 degree on the thermometer. They call that amount a British thermal unit."

Schmidt was very much interested in this term and remarked, "I suppose O'Rourke would rather have it called an Irish unit."

"Now it may interest you to know that a pound of good coal ought to produce something more than 13,000 of these British thermal units. Remember that, for by the time you boys get to be chief engineers everybody will be buying coal by the number of British thermal units it contains instead of specifying some particular brand of coal, as is done now. If you are not buying coal you will be buying fuel oil; but even so you will want to know the thermal units it contains.

"In order not to give you any wrong impressions as to the amount of air necessary for combustion, I want to tell you that for every pound of average coal there are needed about two and two-thirds pounds of oxygen. As the air contains only about one-quarter of its weight in oxygen, it is usual in order to obtain a good draft to admit about 20 pounds of air to the pound of coal. That means that approximately 250 cubic feet of air must be admitted to the furnaces for every pound of coal that is burned. Fortunately, the air costs nothing, or the process of making steam would be very expensive. Although I have advised you to keep the furnace doors open just as briefly as possible, do not forget that some air must be admitted above the fire in order to attain proper combustion. In all well-designed furnace fronts you will find a number of holes for the admission of air, so you must see that they are kept open.

"Now as to the other method of generating heat. All of you have noticed that if you rub your hand briskly over a smooth piece of wood, for example, there is a sensation of warmth. That is due to the energy you exert in the rubbing process. If you do not keep a crank-pin well oiled you know that it will soon become heated up, and if it is allowed to go far enough it is quite possible that sparks would fly or the metal become so heated as to show color. This is but another example of energy being transformed into heat. You all know that the heat from the steam is quite readily turned into power or energy in the engine, so there must be some standard system of comparing one with the other. I have already told you that work is measured in foot-pounds, and that heat is measured in British thermal units. A scientific man named Joule therefore determined that 772 foot-pounds of work was equivalent to a British thermal unit, and that is the way that comparisons are made. O'Rourke, you are quite a strong young man, but you can see that if you hustled as fast as possible, you would not be able to turn out as much work as even 1 pound of coal. That shows you the difference between using your muscles and your brains. Coal is a very cheap and able competitor of the man who only uses his physical strength, but fortunately for mankind brains cannot be bought so cheaply.

"We have seen how heat is generated from coal, and you must keep in mind that heat is the source of all power for marine propulsion. Water is found to be the ideal means of conveyance for transforming the heat into power; it is easily converted into steam and it exists in great abundance. Hence the large majority of marine engines are designed to work by steam generated from water. You know that the result of starting fires in a boiler containing water is the generation of steam. If you put a thermometer in the boiler water you would see that some time after the fires are started the temperature would gradually rise until it reached the boiling point, usually taken at 212 degrees above zero. The heat thus applied is known as sensible heat, from the fact that it is apparent to the senses. After having reached that temperature it takes considerable time until steam is finally formed. This is due to the fact that for water to be turned into steam a great amount of heat is necessary to break up the liquid water and transform it into the vapor—steam. The heat thus absorbed by the water in the transformation is known as the 'latent' heat. To bring about this change there are required 966 British thermal units per pound of water, while it only took 152 British thermal units per pound of water to raise it from the temperature it was put into the boiler, say at 60 degrees, to the boiling point."

"Does this latent heat burn you as much as the other kind of heat?" said Pierce.

"Try it and see," replied McAndrew. "If you stick your hand in water at the boiler temperature I don't believe you will care whether the heat is 'sensible' or 'latent.'"

"If he's sensible I think he will keep his hand out of it," broke in the irrepressible O'Rourke.

"Now," continued the instructor, "you have sometimes heard the expression 'saturated' steam, and I suppose you

think that something must have been mixed with it; but that is not the meaning at all. It really means steam in its natural condition; that is, for every pound pressure on the boiler there is a certain temperature corresponding."

O'Rourke whispered to Schmidt, "I'm on; now I know why they say a man is 'saturated,' like that drunken oiler we had last trip; it was *his* natural condition all right."

"If more heat is added to the steam than is due to that of its pressure then we have what is known as 'superheated' steam; and people are waking up to the fact nowadays, after discarding the use of superheated steam years ago, that there is real economy in it. I think that before long you will see nearly all marine engines using superheated steam.

"If the steam was generated under an atmospheric pressure only, a cubic inch of water would form 1,663 cubic inches of steam. To memorize that fact keep in mind that a cubic inch of water will make nearly 1 cubic foot of steam. Don't follow that rule too strictly, or some time you may be as badly off as the old lady who, when asked for a pound of shot and not having any scales, remembered the old rule, 'A pint's a pound the world around,' and gave the purchaser a pint of shot. Right here let me warn you about using these old approximate rules too freely unless you really understand why they are used and know the correct ones. Engineering is an exact science, and it does not pay to guess at anything.

"Steam, however, is not generated in boilers under atmospheric pressure; therefore I want you to know that while water will begin to boil at a sensible heat of 212 degrees when the steam is unconfined, as the pressure rises, the boiling point is raised correspondingly. Thus at 20 pounds pressure it will not boil until the temperature is 228 degrees, at 50 pounds pressure 281 degrees, at 160 pounds 363.6 degrees, and so on. Perhaps I should tell you here that the pressures I have given are what are known as absolute pressures, and I surmise that you do not know what that term means. It probably has never occurred to you that air weighs something; you breathe it and move through it as if it did not cause any particular resistance, but the pressure is there just the same. Now to understand it you must consider that the atmosphere we move around in is similar to water; the deeper you go in it the greater is the pressure, but as we are generally at the bottom of the air, which is at the level of the sea, we usually have the greatest pressure attainable, and it amounts to 14.7 pounds per square inch. In some foreign countries they speak of the pressure on the boiler not as so many pounds per square inch but as so many 'atmospheres.' Thus a pressure of 10 atmospheres, you can quite readily understand, is ten times 14.7 pounds, or 147 pounds gage pressure. If you were at the top of a high mountain, the air pressure would not be so great and water would boil at a less temperature than 212 degrees. The steam gages on a boiler always record the pressure above the atmosphere; hence to find the absolute pressure of steam you must add to the apparent pressure shown on the steam gage the constant 14.7. This is important for you to remember, for later on when we get to talking about pressures in triple-expansion engines and turbines you must forget about steam-gage pressures and deal in absolute pressures."

"How is it," asked Schmidt, "that this atmospheric pressure don't crush in our ribs?"

"That's a good question," replied the Chief, "and I'll answer you by asking you one. How is it that a thin box without a lid on, sunk at the bottom in 25 feet of water, is not crushed by the water pressure? I'll also tell you the answer, and that is because the water is on both sides of the walls of the box, and it is consequently balanced. So with the human system, we breathe air and get it inside of us and there is a balance. Now if that thin box had a lid on it and was watertight the sides would be crushed by the water pressure."

"Gee!" interrupted O'Rourke, "I'll keep my lid off after this! I don't want my sides crushed in!"

"No danger of that," retorted Schmidt. "You are not watertight—you've got a leak in your throat."

"Following this discussion on the pressure of air, we might as well take up the question of 'vacuum' and get a good idea of that. O'Rourke, what do you understand is meant by a 'vacuum'?"

"Why—er—let me see," replied the talkative one. "Why—er—it's something in the condenser that sucks in your hand if you put it over the air cock."

McAndrew smiled and said, "No; it is something that is *not* in the condenser, and your hand is not 'sucked in' but forced in by the pressure outside; otherwise, O'Rourke, your answer is excellent. You made two guesses and got them both wrong. You might have gone further in your lucid description and said that it was something which smelled bad. The term vacuum really means the absence of air, or the absolute zero of pressure. I have just told you that the air under normal conditions, at the level of the sea, weighs 14.7 pounds per square inch. Now if you pump out all the air from a box or other receptacle there is no pressure in it because there is no air. If a small amount of air is allowed to rush in there will be, naturally, a small pressure, but how much? That is what we want to know, as there must be some means of measuring it. You all have learned undoubtedly that this ship carries 26 inches of vacuum when we are running. That comes from the fact that some early scientific fellow learned by experiment that the pressure of the atmosphere (14.7 pounds per square inch) was the same as the weight of a column of mercury, or quicksilver, as you may know it, 29.74 inches in height. In ather words, a perfect vacuum, or the absence of all air in a condenser, would be shown on the vacuum gage as 29.74 inches. If a small amount of air be admitted the needle on the gage would show a vacuum of less than that, as the balance between the air and the mercury would be disturbed. Finally, if the condenser was opened so that air could rush in freely, the needle would go back to the zero mark. It is customary, therefore, to speak of carrying a vacuum of so many inches, but don't ever speak of having a vacuum of over 30 inches, or people will think you are foolish. As a matter of fact, it is quite difficult on ordinary ships to get a vacuum much over 28 or 28½ inches. As 2 inches of vacuum is equivalent to 1 pound of pressure you can see how valuable it is for the working of the engine to have as great a vacuum as possible.

"While on the subject of vacuum, it will be well for us to take up the subject of how far a pump will lift water. After all this is very simple, as the pump does not lift the water at all; it simply pumps out the air, and the air pressure from without forces the water up the suction pipe. On the same principle as the column of mercury, it has been determined that the unit weight of air (the atmospheric pressure) will sustain the weight of a column of water about 33.5 feet in height, and that is the maximum height that water can be lifted by a pump, so never try to pump water through a suction pipe any higher than that. You can *force* it to almost any height necessary, but you can't *lift* it any higher than 33.5 feet. There is an old saying that 'Nature abhors a vacuum.' It is not so much an abhorrence as it is the universal tendency of Nature to maintain things in an equilibrium or balance. If you disturb this balance by removing the air from anything, the outside air, water or whatever medium it is, will rush in to restore the equilibrium."

Just then, Pierce, who had been leaning back in his chair, intensely interested in what was being said, fell over backwards, much to the amusement of O'Rourke, who remarked, "There she goes again; Nature is restoring his balance!"

(To be continued)

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What Constitutes a Steamship Terminal*

BY H. McL. HARDING†

The importance of terminals, not only for water, but also for rail transportation, has only lately been fully comprehended. When it is stated that of the $1.59 (6s. 7½d.)—the transportation expense of a ton of freight of a certain classification between New York and Galveston, a distance of 2,000 miles—80 cents (3s. 4d.) represents the terminal expenses, and the remaining 79 cents (3s. 3½d) all the carrying expenses, it is evident that the subject is well worth attention.

When the cost at the New York and Washington freight terminals in rail transportation is at least double all the costs of carrying between these two cities, it is of some interest to secure full information.

Finally, when in these days of agitation against high transportation rates, it is stated by two of the most important business men in a Western city located on the banks of the Mississippi, who are most friendly to water transportation, that after repeated trials the terminal expenses employing manual labor from the boat up the levee to the top of the bank was more than the saving of water over rail carriage, evidently the question of terminal improvements, especially on our inland rivers, cannot well be postponed for future consideration.

In one case where the material was floated down the river on a raft belonging to one of these men, and costing nothing for carriage, the terminal expenses were more than the saving effected by no cost of carriage.

Most remarkable figures have been submitted as to the influence of the cost of transportation upon the cost of living, and, as has been proverbially asserted by the president of the New York Central Railroad, "the cost of transportation affects every man, woman or child who wears clothing or eats food." None can escape it, the greatest or the least.

As the total of terminal charges as shown is such a large proportion of the transportation charges, terminals should no longer be regarded as the appendix of transportation, but as of equal value with the channel and the steamship, the rail and the locomotive.

Although reference to the economy of terminals has been given first, yet by most transportation managers economy at terminals is subordinated to rapidity; that is, rapidity of movement is considered even more essential than economy.

The charter value of a large coastwise steamship may be $400 (£83 6s. 8d.) per day. One day saved on the time of one ship's trip represents no inconsiderable amount. On a fleet of a dozen vessels it means increased dividends.

On the inland rivers, where there are a number of landings to be made on each trip, and where by means of powerful searchlights night travel can now be made as quickly and as safely as by day, rapidity of movements attained by electrical transferring machinery, requiring few men, indeed, on the vessel or the shore, signifies many more trips per season, and may add that one thing which was needed to round out the full measure of successful inland water transportation.

Provided there are complete terminals with no terminal elements lacking, the greater possible rapidity of river-terminal freight movements over possible rail-terminal movements can often more than equalize the greater speed of the locomotive over the "power boat."

A thousand tons of miscellaneous or package freight from a properly designed barge can be discharged, including assorting and distributing according to consignments, in but a fraction of the time it would require to unload 1,000 tons of such freight from over 100 freight cars. Not only so, but the barge-loading and discharging can go on simultaneously. Hence

1. Greater freight transferring rapidity at water terminals over that at rail terminals can more than neutralize the advantages of the greater speed of rail carriage over water carriage between the terminals.

2. Possible water-terminal saving in freight transferring over the expense of rail-terminal transferring can be made more than even the saving in water carriage over rail carriage for the average trip distance.

3. Properly designed and mechanically equipped terminals, co-ordinated with land transportation, are vital to the competitive success of water transportation.

While the type of boat may not come within the province of terminals, yet a boat not suitable for quick loading and discharging should not be adopted if rapidity and economy are to be attained. It may be said that the steamboat on the rivers should be for passengers, but the power boat with barges for freight.

There should be in one tow large steel barges for large cities, smaller barges for the towns and villages, and the smaller barges divided into sections, each section representing a small village or landing. The discharging, assorting and distributing should be performed by one continuous operation of the machinery.

At the largest cities a barge to be discharged is left and a full one taken. The power boat is the locomotive and the barges are the freight cars, some of which, as on the German rivers, may have a capacity of from 1,000 to 3,000 tons, each equal to that of a coastwise steamship.

The tonnage will often be limited by the river's depth. An 800-ton barge can be towed where there is only 6 feet of water.

Some barges may be regarded as floating terminals. The freight can be loaded directly into them by electric machinery as received from the shipper, and be assorted and distributed according to consignments when discharged by the same type of mechanism.

There are many elements of a successful terminal, and these differ according to the location.

General Plan for Initial and Future Development

After it has been approximately determined what will be the tonnage to be handled at a terminal, then the lengths of the lineal frontage can be estimated, the dimensions of the various sheds and warehouses closely determined, the length of the storage tracks and the amount of the machinery to give the necessary transferring capacity.

The Structure of Piers, Bulkheads and Quay Walls

The nature of the structures should largely depend upon the importance of the terminal. For the larger terminals along the inland rivers there are recommended concrete quay walls; at those of terminals of medium size, concrete or reinforced steel piling; and at the smaller terminals, wooden piles and trestles, the lower portion of which should be properly treated.

Transshipment Sheds

It may be said that transshipment sheds upon piers should be of one story, 40 feet in height, their length and width depending upon the location.

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The function of transshipment sheds is chiefly as a place for the purpose of transshipment to other steamships, to barges and lighters for temporary holding, for inspection or distribution, or as a passageway to the transfer sheds or to the warehouses.

The transshipment sheds are not to be used for the storage of freight, and should be kept as free from hold-over freight as possible. Such freight as must be held for twenty-four hours or more for transshipment should be tiered high to economize floor space and to avoid congestion. By the installation of transferring machinery such freight as is often held within the transshipment sheds because there is no other place for it, or on account of the great expense of moving by manual labor, can be taken directly to the transfer sheds or warehouses for storage at small expense.

Transfer Sheds

To the rear of the projecting piers and transshipment sheds are the transfer sheds for the transference to and from the cars or drays, and for a shorter time storage than the warehouse storage. Within the lower section of such transfer sheds may be the railway tracks and platforms, dray areas and dray platforms. Longitudinal openings extend the whole length of the sheds between the upper and lower sections. As there can be a large number of transfer sheds, certain of these can be rented for the exclusive use of merchants or transportation companies instead of transshipment sheds, which is the usual custom.

Warehouses

To the rear of the above sheds, more remote from the water's edge, may be the warehouses for long-continued storage. These will be of several stories, the lower story being reserved for the car tracks and dray platforms. This lower story is 14 feet in height, and the upper stories of sufficient height to permit of high tiering. Other buildings and structures, such as power houses, coal trestles and elevated coal pockets, should be provided where the terminal is of sufficient size. There should be cold storage warehouses and market sheds. The terminal industrial section, the private industrial section and the residential section form part of a complete terminal.

Correlation of Terminal Elements

All the elements of a terminal should be connected or tied together by surface railway tracks and overhead transfer tracks. It should be possible to move freight between the vessel, the different sheds and warehouses, by mechanical methods, including assorting, distributing and tiering. To perform the different freight movements rapidly and economically by mechanical methods is an essential requisite to a successful terminal.

Conditions to be Fulfilled by Any Freight Transferring Machinery

There are three great principles in cargo transferring or freight handling, which must pertain to any machinery to fulfill all terminal conditions. These constitute the touchstone by which any machinery should be tested to determine its value:

1. That the machinery itself should be able to serve every cubic foot of space (which is to be utilized).
2. That the machinery should do this without any rehandling by manual labor.
3. That there should be continuous rapidity.

If, due to peculiar conditions, all these cannot be fulfilled, then as many as possible.

Freight movements consist in the receiving, inspecting, assorting, scribing, starting, calling, weighing, routing, distributing, checking, stowing and rechecking, all of which should be provided for in the most economical manner.

Types of Machinery

The types of machinery which pertain to miscellaneous or package freight consist of moving platforms, slot conveyors, portable conveyors, tiering machines, link belt conveyors, rubber belt conveyors, overhead chain and hook carriers, ramps, horse, motor and derrick trucks, winches, elevators, cranes such as the fixed jib cranes and pillar cranes, or the movable cranes as the gantry, walking or the traveling shop crane, transporters, overhead carriers, telphers, man trolleys, transfers and many others.

Attention is called to the latest types, especially to those used at German and English terminals. These devices consist in overhead trackage and transferring and hoisting machinery. There are two leading types which will be described. The power is electricity, preferably of direct current of 250 or 500 volts, and can be rented economically from the local electric light and power companies.

In one type the overhead tracks consist of an I-beam supported from the structure of the building, or if outside, upon bents. Upon this I-beam or upon one side of the lower flange, with an intervening strip of wood between, is placed a T-rail upon which travels the conveying mechanism.

In another type the rails are placed upon the lower flanges of the I-beam, but, although this type has many uses, it is difficult to serve the whole area between the fixed side tracks.

In the sheds the whole of the main side trackage is fixed in a permanent position, but the cross trackage is fixed or movable, and when movable, being attached to a traveling crane and so arranged that the hoisting and transferring mechanism can pass from any point of the fixed side tracks to the movable cross track, and then upon the fixed track on the other side, and thus complete the circuit of the movements.

This conveying mechanism consists of a transfer tractor which draws after itself from one to four trailers, each trailer supporting an electric hoist. This transfer tractor constitutes the traveling conveying mechanism, having a speed up to 9 miles an hour with its complement of trailers and 6 tons of freight. It is controlled in the same way as an electric trolley car, by a transfer man in the transfer tractor cab operating a drum controller, the current being taken by a contact wheel from a wire or other conductor located parallel to the track in the most convenient location, or in some special cases by a storage battery attached to one of the trailers.

Each trailer has suspended beneath it an electric hoist, which might be called a traveling electric winch. It has all the functions of the winch except that it is movable. The normal load of each hoist is 2 tons at a speed of 60 feet per minute. There is a reserve capacity of 50 percent. The hoists, when coupled together in pairs, can lift 4 tons. One ton would be hoisted at a speed of approximately 120 feet per minute.

The three hoists would therefore have a combined capacity of 6 tons, not including the reserve. The hoists are also equivalent to traveling elevators. This conveying and hoisting machinery contains no new mechanism, and can be furnished by a number of manufacturers.

This transporting machinery consists of two essential features—one mechanism which conveys and another which hoists, and this mechanism is able to transfer the freight with one conveying movement.

Operating Costs by Machinery

The sections of a terminal as they are developed will be connected by overhead runways, so that the same transfer tractors and trailers can be used upon different sections.

Although the cost of transferring freight will largely depend upon its character—that is, upon the relative proportion of its bulkiness to its weight—yet the actual cost of hoisting and

transferring should not average more than 6 cents (3d.) per ton for a complete cycle. This does not include the expense at each end of the movement—that is, before the hoist hook is attached, or after the load is deposited, which on the average should add from 6 to 8 cents (3d. to 4d.) additional.

The 6 cents (3d.) for hoisting and transferring may be divided as follows:

Labor, 15 percent of transference cost. Interest and amortization, 30 percent of transference costs. Electricity, 20 percent of transference costs. Maintenance, 20 percent of transference costs. Incidentals, 15 percent of transference costs.

It must be emphasized that all such figures must vary under different conditions or locations, but there will not be, on the average from many places, a wide variation.

The cost of manual labor per ton for miscellaneous freight is from 36 cents (1s. 6d.) upward. The following figures, although often used, will serve as a general guide as to the expenses at the most expensive seaport in the United States:

Present Manual Labor Costs, Handling 2,000 Tons in 17 Hours.—Loading costs per ton. Labor only, including tiering, 36.6 cents (1s. 6.3d.).

Discharging cost per ton. Labor only, including tiering, 39.15 cents (1s. 7.58d.).

Mechanical Operating Costs for 2,000 tons in 17 Hours.—Loading costs per ton. Labor only, including tiering, 13.028 cents (6.51d.).

Discharging costs per ton. Labor only, including tiering, 14.575 cents (7.29d.).

Advantages of Mechanical Transference

The advantages of mechanical transference may be summed up as follows:

1. Greater rapidity of loading, unloading and distributing. The time of transference can be reduced by one-half or less in comparison with manual labor.
2. Economy per ton handled. A saving effected of more than one-half.
3. Increased holding or storage capacity.
4. Greater working capacity.
5. Less car detention and demurrage, meaning fewer cars to transport a given tonnage.
6. Saving in terminal investment.
7. Improved dray service and reduction in damage claims from breakage.
8. Reduced yard switching charges.

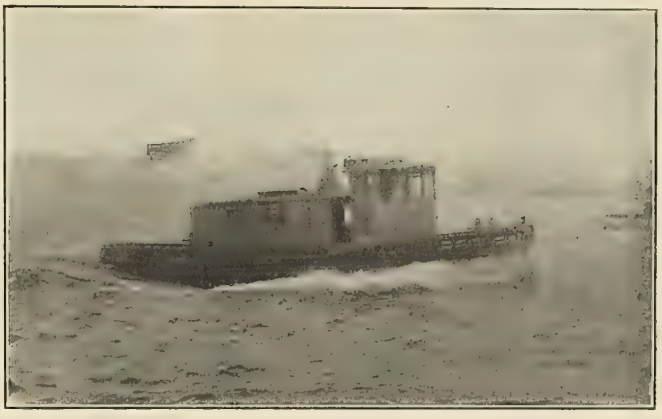
Conclusions

From the above it may be deduced that a complete terminal for water transportation should consist of a combined water and rail terminal with large land and water areas, with many feet of lineal water frontage, piers or quay walls, of sheds, warehouses, car tracks, dray areas and platforms. There should be industrial and residential sections and trade markets, closely allied to the terminal. All of these should be so equipped with modern transferring machinery that cargoes can be rapidly, economically and continuously transferred without rehandling from one terminal element to any other.

Test of a Rumely Marine Oil Engine.—A 125-horsepower, six-cylinder, compressed air-starting and reversing marine engine, built by the M. Rumely Company, La Porte, Ind. (for description see page 126 of the March, 1912, issue of this journal), has been run under severe test conditions for seven months, developing a maximum of 170 brake-horsepower. All of the tests were run on 5-cent kerosene (paraffin), and most of the time the engine was under a load of 145 brake-horsepower, running at 350 revolutions per minute. The fuel consumption at this power was .71 pound per horsepower-hour. Starting (with 50 pounds air pressure) is instantaneous, and reversing is accomplished from full speed ahead to full speed astern in three seconds.

A Mietz & Weiss Motor Tug Boat

A new development in the internal-combustion engine for tugboats, as well as for good-sized freight or passenger boats, is indicated in the accompanying photograph, which shows a tugboat 53 feet long by 12 feet 6 inches beam by about 5½ feet depth, equipped with a four-cylinder Mietz & Weiss reversible oil engine. This engine is of the two-cycle type in which the preliminary air compression for scavenging takes place in the crank case. It is well known that the reverse gear which has brought about the application of the small internal-combustion engines in thousands of boats is not suitable for the large sizes, because the output of the engine increases at the square of the diameter of the pistons, while the requirements for the clutch go up in direct ratio of the horsepower, which means that we do not have to go up very high in horse-



TUG BOAT FITTED WITH REVERSIBLE OIL ENGINE

power before the clutch becomes larger than the engine. But apart from this there is naturally a tendency, and particularly for marine work, to simplify the mechanism to increase its reliability. The two-cycle engine is particularly desirable with its impulse every turn for a marine engine. It reduces the weight, and is productive of almost constant torque at the propeller shaft.

For certain reasons that are to be considered in a two-cycle engine, the controlling lever which admits the air to the distributor must, on its first movement, cut out the oil injections, so that the minute air of higher pressure than the atmosphere is admitted to the cylinders; there is no charge formed which might then bring about an abnormal pressure. The mechanism is therefore arranged so that the oil injections are positively locked at the first move of the lever for either direction of rotation. A further movement of the lever admits air in whatever direction of rotation the engine is supposed to run, and not until the engine is in motion will the oil injections take their regular course from the pump, which is controlled by the governor, to the cylinders in their various sequence.

The distributing valve is nothing but a rotating valve driven by the shaft of the engine with ducts cut in the casing to admit the air to the three or four cylinders, whichever the engine might have, in the proper order of its rotation. The controlling lever, which is attached to an ordinary two-way cock, admits the air, either for forward or reverse or in its central position shuts it off entirely. There is no other mechanism necessary, and inasmuch as the engine shaft is directly coupled to the propeller shaft there is no fly-wheel required, and as a matter of fact the engine in its outward appearance resembles a steam engine rather than the ordinary internal-combustion engine with its clutch and fly-wheel.

One feature of this engine should be mentioned, and that is the speed reduction that can be had by the throttling lever. By the throttling lever, which acts on the injection pump, and

which in this case brings it down to about 80 to 100 revolutions per minute, at which the engine can be going constantly, just barely to move the boat, while the maximum speed at full force is 340 revolutions per minute.

Engines as high as 400 horsepower are at the present time put out by the builders under certain rigid guarantees as to oil consumption, manipulation and general performance. Units of 200 horsepower in cylinders 14 by 18½ inches, and units of 100 horsepower in single-cylinder engines, 18 by 27 inches, with a speed of 180 revolutions per minute, are also built.

Stability of Ships—Notes for Commanders

BY GEORGE NICOL

In the year 1883 the *Daphne*, a little steam vessel building on the River Clyde, capsized while launching, causing great loss of life. This was probably the greatest disaster in the annals of shipbuilding up to that time; certainly it was an event that marked the beginning of an epoch in the design of merchant vessels. The stability of ships, from being a subject of academic interest merely, became one of first-rate practical importance, and in the decade following the *Daphne* disaster more original research work was done in this branch of naval science than in all the years before. Shipbuilders were at last awakened to the importance of this element in design, and stability calculations became the everyday work of the drawing office. Nowadays, most men with a shipbuilding training are versed in the principles of stability, and it is not too much to say that repetition of the disaster of 1883 is very unlikely indeed.

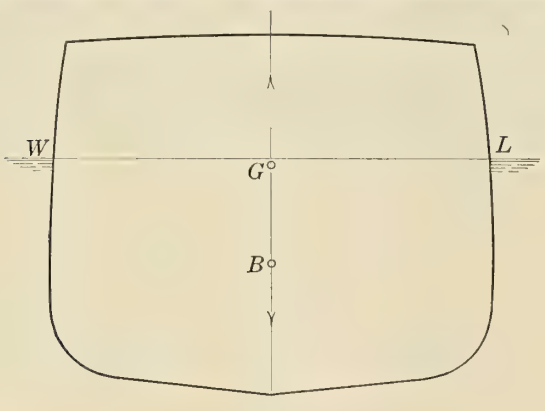


FIG. 1

But a ship is only on the threshold of her career when she leaves the builder's hands. We now know that however well designed a vessel may be, she may yet not be immune from calamity if badly managed afloat. By injudicious loading a good ship may give no end of trouble and its very existence may be endangered. It has taken the shipping public a long time to grasp this. Disasters innumerable there have been, the evidence concerning which has pointed to insufficiency of stability; but other causes have been brought in to confuse the issue, and the main cause has thus escaped receiving the attention it deserved.

In some cases, however, in that of the *Waratah*, for instance, instability was so obviously the cause of the loss that the court could come to no other finding. It is to be hoped that something will now be done to deal effectively with the question of the stability of a loaded ship—to deal with it in such a way as to render unlikely the putting out of any ship to sea in a dangerously unstable condition.

The problem presented here is not an easy one. Not that the principles of stability are difficult, nor yet their application to this special case, but that few of the men who control the loading of vessels, however skilled as packers, possess even the most rudimentary knowledge of the stability of floating vessels. The problem then is one of how adequately to educate stevedores and commanding officers in this—to them—all-important subject.

The crux of the difficulty is the absolute lack on the part of such individuals of essential elementary knowledge of mechanics and hydrostatics. It is idle to talk of figures to one who has not mastered the multiplication table, but not more so than to speak of a moment of stability to a man who has never heard the term moment employed otherwise than as a measure of time. In the writer's view, no progress will be made until men in charge of the loading of ships have suitable theoretical training. To many the word theoretical is alarming. What does the practical man want with it? say they, with emphasis on the *practical*. This is a grand mistake. Theo-

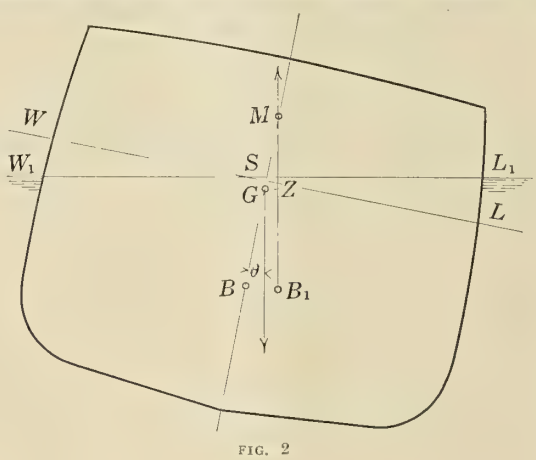


FIG. 2

retical training is more essential to the practical man than to any other. It will guide him in his practice, prevent him falling into rut methods, help him to bridge gaps in his work otherwise impossible.

The theoretical knowledge required of a loading officer is of the simplest character, but it should include the following: What is meant by (1) displacement; (2) center of buoyancy; (3) center of gravity; (4) a mechanical couple. All men who have to do with stowage operations, from practical observation, know that a ship sinks in the water when cargo is shipped, and rises out of it when cargo is discharged. They know this, but not all of them grasp the fact that the weight of water in the layer through which the ship sinks or rises and that of the cargo shipped or discharged is the same. If they did so the deadweight scale would have a new meaning to them.

Again, the center of buoyancy is commonly described as the center of the volume of displacement. Its importance lies in the fact that the line of the aggregate upward pressure of the water passes through it; thus whatever be the position of a vessel in the water, the direction of the upward pressure is always easily determinable.

The center of gravity is the center of the entire floating weight, *i. e.*, of the ship and cargo. It is the point through which the total weight acts however the vessel be inclined. In regard to the term "mechanical couple," it may be said that

any two equal and opposite forces acting in parallel lines at a certain distance apart, constitute a mechanical couple. In the case of a floating ship the two equal forces are the downward weight and the upward pressure. These forces are always in operation. If a ship is at rest it simply means that the arm of the couple is zero; that is, the forces act in the same vertical line. Fig. 1 illustrates this condition, B is the center of buoyancy, G the center of gravity; the lines of the forces are coincident with the middle line of the ship. Now let the ship be heeled from the upright. Fig. 2 shows the new condition of things. The under-water form alters in shape; the center of buoyancy is now at B_1; the center of gravity, however, does not change, no weight having been moved on board. Thus, in this case, the two equal and opposite forces act with an arm between them, a mechanical couple being in operation on the vessel. Let W be either of the equal forces, and $G\ Z$, the

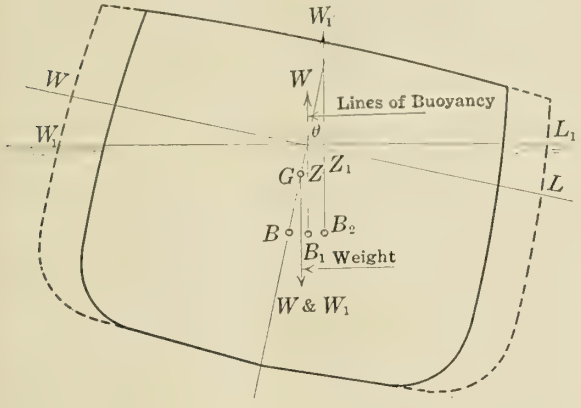


FIG. 3

distance between them (Fig. 2), then the product $W \times G\ Z$ is the moment of the couple and measures its power to turn the vessel. In books on mechanics innumerable examples of mechanical couples are instanced. The training of a stevedore, then, should include a knowledge of mechanics sufficient to make the preceding points perfectly clear. Anything beyond this, however, is non-essential.

Quite as important as the foregoing is the need of training the beginner to think, so to speak, in drawings. If his attention were directed to a drawing such as Fig. 2, and he were told it was a transverse section of a ship, it should express a perfectly clear idea to him. In his mind's eye he should see the body of the vessel tapering in each direction beyond the section. If he could do this he would see the form of the wedge $L\ S\ L_1$; for instance, as something like a slice of a much elongated orange. He would also be able to predict the effect of change of form on the positions of B and G. He would know that fining the lower form would raise B and move slightly G, and very soon he would grasp the effect of this on the stability. He would also be able to appreciate the influence of breadth. It is commonly understood that broadening a vessel increases her stability, but the officer trained to think in drawings could explain this to himself and others.

He could make a sketch like Fig. 3, for instance, and show the precise effect on stability of increasing a vessel in breadth by a given amount. For simplicity, he would assume B and G to be at the same height in both cases, the change in the stability being then entirely due to the increase in breadth. At any inclination, θ, say, the center of buoyancy in the original vessel moves out to B_1, and in the broadened one to B_2. The resultant upward pressure passes through these points. The downward forces pass through the same point G in both cases. The righting arm increases from $G\ Z$ in the original vessel to $G\ Z_1$ in the broadened one. In the latter case, too, there is an increase of displacement; thus increase of breadth augments both factors of the stability moment, namely, the weight and the leverage. All this is obvious from Fig. 3. The importance to the loading officer of being able to express himself in a drawing can, therefore, be hardly overestimated.

In the writer's opinion a method of instruction likely to be

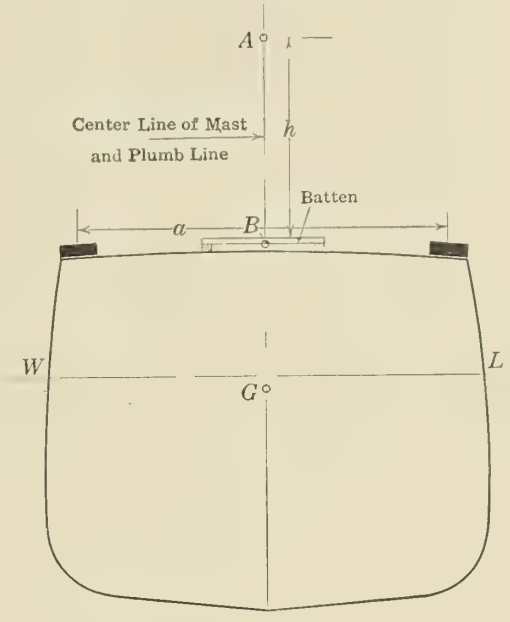


FIG. 4

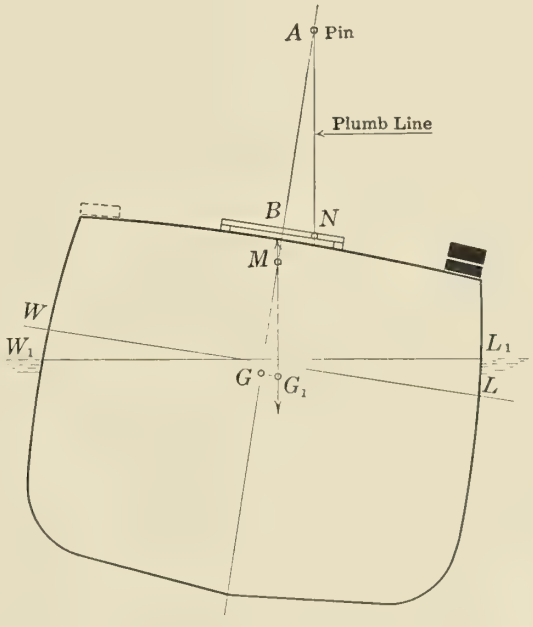


FIG. 5

fruitful of results is one involving the use of models. A man to whom a drawing is a mystery, and a demonstration in algebraical symbols about as intelligible as Greek, may readily grasp the meaning of a practical experiment. He cannot fail to note a concrete result, although unable to follow the steps that lead up to it.

Thus the effect on stability of increasing the breadth may be demonstrated as follows: Place two models of the required proportion, of the same general contour of lines, and loaded to the same draft, in a tank of water. In each let there be a vertical mast, having a string, or fine wire, attached at the same height above the deck, to provide a means of forcibly heeling the models. There should be an arrangement for measuring the force of the pull in each case. When the models

have come to rest in the upright position, let a gradually-increasing pull be exerted upon each until they reach the same angle of heel, say Θ. It will be found that P_2, the force required to hold the broad model at the inclination, is greater than P_1, the force necessary for the narrow model. Since the upsetting levers are the same the forces are measures of the righting moments in operation. Thus the effect of increasing the breadth is, as previously shown, to augment the stability.

To show the importance of exercising care in stowage, consider the following experiment: Hollow out the model it is intended to use so as to provide a space to correspond to the hold of an actual vessel. Into this space stow blocks of material of various densities. In the first instance, let the heaviest pieces be placed lowest in position. Now heel the model to some angle as in the previous experiment, and ascertain the force of the pull. Next, remove the blocks and replace them with the lightest lowermost. Heel the vessel to the same angle as before and measure the force. The pull in the second case will be found less than in the first, showing a falling off in the righting moment, a state of things entirely due to the rise in position of the center of gravity.

Lastly, fill up the cargo space with very light homogeneous material, and to bring the model to the required draft pile the cargo on the deck, the case corresponding to that of a vessel carrying a deck load. Suppose the model forcibly held in the upright position during the loading, and, on release, that it heels over and comes to rest at some moderate angle from the upright. This shows the model, as loaded, to be initially unstable. Now exert a pull on the mast string and incline the model still further, holding it at rest at the increased angle. That a certain force is necessary to do this shows the existence of a positive stability moment in this position. Thus a vessel, initially unstable, may not be completely so. In an actual vessel with such characteristics, if a portion of the cargo were removed, and a compartment of the ballast tank run up, she would regain an upright position and might be navigated with confidence. The filling of the tank, however, would have to be done with great care and in perfectly still water, as loose water causes a reduction in stability.

If, instead of coming to rest at a moderate angle, the model on release after loading turned turtle, her condition would be one of complete instability. A vessel of the type of such a model would, of course, be unsuitable for deck loads.

We have indicated how important it is to know the position of the center of gravity when considering a vessel's stability. The use of a model affords a specially convenient means of explaining the experimental method of determining the point. The necessary calculations are simple, but two principles are involved which must be understood. One is that if a single weight in a system of weights be moved through a certain distance, the center of gravity of the system will move in a parallel line, in the same direction, through a corresponding distance, which bears the same ratio to the first distance that the single weight does to the weight of the system. The other principle is that the corresponding sides of similar triangles are in proportion. The method of the experiment may now be explained: Fig. 4 shows in section a model floating freely and at rest. From a pin on the mast a plumb bob is suspended, as shown. On the deck a horizontal batten is fitted. On each side of the deck, as far out as possible, weights of equal amounts are placed. Let the distance between the centers of the weights be a and the length of the plumb bob h.

To begin with, the position of the plumb line, when the model is upright, is marked on the batten. Then the weight on one side is moved across the deck and placed on top of that on the other side, the model heeling in consequence and the plumb line taking up the position $A\ N$. Now suppose G to be the center of gravity of the model before the movement of the weight. After the movement it is in the position G_1, and a vertical through this point intersects the middle line at M. The model is again at rest; Fig. 5 shows the new position. Clearly, the triangles $A\ B\ N$ and $G\ M\ G_1$ are similar, therefore by one of the principles mentioned

$$\frac{G\,M}{G\,G_1} = \frac{A\,B}{B\,N},$$

and

$$G\,M = G\,G_1 \times \frac{h}{B\,N} \qquad (1)$$

substituting for $A\ B$ its given value h.

If each of the heeling weights be w, and the total displacement of the model W_1, by the other principle

$$\frac{G\,G_1}{a} = \frac{w}{W},$$

or

$$G\,G_1 = \frac{w.\,a}{W}.$$

Substituting in (1)

$$G\,M = \frac{w.\,a}{W} \times \frac{h}{B\,N} \qquad (2)$$

All the terms on the right-hand side of equation (2) are known, therefore $G\ M$ is known. Now M is called the transverse metacenter. It is approximately fixed in position for all small inclinations from the upright. A diagram of metacenter is made from the drawings of the model from which the position of M corresponding to any draft is easily obtained. Since the height of M is therefore known it is only necessary to measure down the distance $G\ M$, as found above, to determine the position of G.

Take an example: A model 17 feet long has a displacement of 1,700 pounds; calculate the value of $G\ M$, given that a weight of 5 pounds moved 24 inches across the deck, deflects a 12-inch plumb line .56 inch. Substituting the values given in equation (2) we have

$$G\,M = \frac{5 \times 24 \times 12}{1{,}700 \times .56} = 1.51 \text{ inches.}$$

To get the height of the center of gravity above the base line, this value of $G\ M$ is deducted from the height of the metacenter as given in the metacenter diagram.

In performing this experiment with an actual ship the process is practically the same as the foregoing, the units, however, being a foot and a ton. Space will not permit us to proceed further, but we have by no means exhausted the possible applications of model experiments as means of conveying instruction on this important subject. The effect of a shift of cargo, of bilging a hold compartment, of filling double-bottom tanks, etc., may be studied in this way, and much more convincingly than by abstract investigation of a ship's drawings. In any adequate scheme of instruction, model experiments should therefore play a prominent part.

SHIPBUILDING IN JAPAN.—According to a report from the British Consul-General in Yokohama there are 230 shipbuilding yards in Japan. During the last year these yards turned out 77 steamers of 24,479 tons and 147 sailing vessels of 11,097 tons. This is a decrease of 58 sailing vessels from 1910 but an increase of 19 steamers, the tonnage of the latter, however, decreasing 38,996. All of Japan's leading steamship lines are preparing to build additional steamers for foreign service, mostly medium-size freight and passenger vessels. Japan's total shipping now includes 2,545 steamers of 1,233,909 gross tons, 6,392 sailing vessels of 414,720 gross tons, and in addition a large number of junks.—*Engineering.*

The Handicap of the Technical Graduate

BY PROF. H. A. EVERETT*

One occasionally hears from those engaged in the actual building of ships complaints of the incompetency of the technical graduate, and it is a very serious charge. In many cases the complaints come from careful and thoughtful managers, and these need our most careful attention. To illustrate by a specific instance, a gentleman recently stated that the technical graduates which he had received were no better than the apprentices trained in his yard beside whom the graduates had been placed at work, that they were impatient for advancement, and that in many cases had not had sufficient practical work to make them of much value at the bench or in the yard.

Narrowly judged, this is true, and must always be true, but in its broader sense it is entirely false, for the aim of the technical college is not to turn out apprentices or even mechanics. The first short interval of time that the technical graduate is employed by any manufacturing company is by no means a fair test of his value, yet it is in this period that the major part of the dissatisfaction is felt on both sides, employers and employees.

The true graduate of the technical school is not a practical man when he graduates, but has the training to learn rapidly to become one, and then will be able to do what the man of practical training only can probably never do. He has been trained along the technical lines of his profession and has been given such practical work as can be crowded into his curriculum without sacrificing the important technical elements, and is a man who goes out into the world upon graduation equipped with a technical training and a mental development which is intended to permit him to acquire the practical work of his profession and the details of the business of his employer in a quick and accurate manner. He is *not* and *should not be supposed to be the equal* in practical work of the apprentice who has spent a time equivalent to the graduate's *four years' technical training* in the *actual practice of his trade.*

A young man comes to a technical college and devotes four years of his life to the work here. In that four years it is his object to get the most out of it that he can, and it is the object of the school to give him the most that can be given in the time available. The question of choice of courses, or rather the items which shall be taught, is a broad one, and there is a constant pressure from outside to increase the proportion of practical training. To a certain extent this is desirable, but only to a very limited extent, for while the student can readily acquire practical training upon graduation, it is extremely difficult for the practical man to pick up the technical work. Consider a moment the result of largely increasing the details of construction taught and the practical work given in the courses. The time available for work is in practically all institutions almost entirely utilized at present, and it would be necessary to drop some of the technical subjects now taught. What should be dropped is a very interesting question, and if any two competent practising naval architects could agree on what items should be dropped it would be most surprising. Our experience has been that when pressed for specific courses which should be dropped, the answers have been as varied as the number of individuals asked, and the reason is not difficult to see, for while each may honestly quote some line or sort of work which he has not had occasion to use in *his personal experience*, the experiences vary as much as the individuals. Only very recently a gentleman eminent in his line, the manufacturer of a certain form of ship equipment, told me that since graduation he had had no occasion to use his higher mathematics. It so happened that this man's firm had only the previous year applied to us for a man, and had specifically required that the man be competent to handle with facility higher mathematical calculations. I afterwards found that calculus and spherical trigonometry were what had to be used, and *were* used in the design of the article which this firm was producing. On calling the complaining gentleman's attention to this he admitted that quite truly he had used his higher mathematics in the development of this article, but had forgotten it. Here is a case where a man technically trained used his training *without realizing it,* and used it where the non-technical man would have failed, and this occurs even oftener than most of us realize. The technically trained man has the training and the ability to use it to meet the *emergency,* and it is this meeting the *emergency* which makes a man valuable, not the satisfactory completion of the routine work. If the present curriculum were modified to include radically more practical work (at the expense of the technical training) it would be extremely difficult, after graduation, for the student to increase his technical knowledge to anything like the amount which he has with the technical training on its present plane.

This is a thing which seems to be entirely overlooked by a great many employers of labor, especially in the shipbuilding line. They want a man from the technical college, they invariably want one of the "best men," they expect that man to be trained in the practical details of ship and engine construction, in the technical work, and still further to be trained in the details which are special to their own yard. If the man they obtain is not fully conversant with the details of the work upon which they have found immediate use for him, they are disappointed and give utterance to the complaint before stated. This is wrong and the fault does not lie with the technical school in any way. These men must, and have, sacrificed practical work to the technical, which means that the student on graduation must serve a certain length of time in a shipyard in order to make himself familiar with the details of the profession in which he is to engage. This is a thing which must be acknowledged by the employer and which should be made easy by him. Practically all employers agree that if a technical man has been out five or ten years he is a very valuable man, and they would rather have him than any practical man that they could pick up, and yet in many shipbuilding works they are not willing to make the sacrifice which is necessary for the first few years to hold the graduate in the profession.

Look at it from the young man's point of view. He has spent four years in a technical college, and has spent, we will say, from $2,000 to $3,000 (£974 to £1,460). If he goes into a shipyard and cannot then receive a living salary, regardless of his predilection for the work, he feels forced to secure work in other lines which *will* offer him a higher remuneration, so that at the end of the two or three years the result has been that the profession of naval architecture has lost a good man merely because shipyards were not willing to pay a living wage for the first few years. I think that this can be most forcefully brought out by a diagram. If we trace two curves which we might call curves of advancement, showing salaries as ordinates and time as abscissæ, the curve for the non-technical man would look something like a curve *A* in the diagram—that is, his rate of advancement would be considerably higher at the start than the technical man's up

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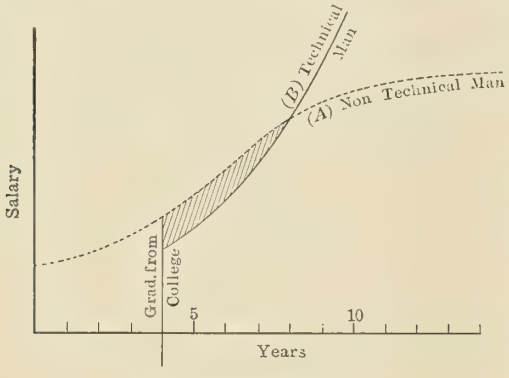
to perhaps six or seven years, but from here on his advancement is apt to be very slow. Considering the curve *B* of the technical graduate, the rate of advancement for the time through college is nil, he begins his work at a very low salary in many cases, and for a few years subsequent to graduation his rate of advancement is not much faster than the corresponding rate for the non-technical man, but at the end of perhaps five or six years after graduation his rate of advance is considerably faster than the other man's.

Now it is the section between the two curves that is indicated by the shaded area which causes the present trouble. If the technical graduate can struggle long enough to get by the shaded portion of this curve to a place where his advancement is fairly proportionate to his capacity, he seldom quits the profession. On the other hand, if he gets discouraged previous to reaching this place, he enters some other line of work which offers more remuneration immediately.

It is of little value to make statements with reference to existing conditions which may not be as we wish them unless specific suggestions for their betterment accompany them, and



CURVES OF ADVANCEMENT

it is this that I have in mind. There are things which can be done by the technical school, and there are also things which can be done by the shipbuilder, all of which will tend to minimize the troublesome shaded area.

The technical college can increase the amount of practical work accorded to its students if the shipyards will *co-operate* in permitting men to obtain practical experience in summer, and in making suggestions to the faculty as to lines along which practical details are found to be needed. Some yards dislike to take men for short periods during the summer, claiming that they are merely a nuisance, which, to my mind, is largely a reflection upon the *management* of the men and the tasks allotted to them. Summer work, in conjunction with the regular course of the school, has worked out to advantage in many of the foreign colleges and is a fixed part of the curriculum of the Royal Naval College at Greenwich, the Ecole d'Application du Genie Maritime at Paris, Technological High School at Berlin, and in the Imperial University at Tokio, Japan, in which latter place the work done by the students is inspected by members of the faculty and a mark is given for the summer work. Furthermore, the technical school can counsel its graduates to have *patience* while acquiring the practical work.

On the other side, the shipyards can do much if they will be willing to accept technical graduates on some sort of a thoroughly understood basis whereby the men are started at a wage which is a living salary, put through whatever practical work it is desired to have them undertake, and at the end of a certain period of probation put them on the yard's permanent force at a reasonable salary, or discharge them. Some shipyard managers think this is a radical thing. It does not seem so, and I can cite many instances where it has been actually done in manufacturing organizations employing technical graduates, and has reacted to the tremendous advantage of the concern.

One concern which I have in mind has a practical understanding with a large technical school, whereby one or two men are furnished to this company each year. These men are accepted by the company on a three-year understanding; payment for the first year is about $15 (£3 2s. 6d.) per week, with an advance in the second and third years, which is dependent largely upon the ability of the individual. The first year the company may, in some cases, lose money on the man whom it employs, the second year it surely comes out even, and the third year there is a financial gain to the company. Then the man is either retained in a position of some responsibility or discharged. The result is that a man knows on going there that there is a long period of probation, in the second place he is able to live during this period of probation, and in the third place he is a man trained in the peculiarities and details of the business which is to follow at the time when the business wants him.

If such an arrangement as this operates to the advantage of the mechanical engineering profession, I can see not the slightest reason why it should not operate to the advantage of the naval architectural profession. Furthermore, this same sort of thing has operated to advantage in a concern which is doing a large business along what may be termed non-technical lines. Unless some such arrangement is brought about the result will be in the future, as it has been in the past, a drifting of the technical man, trained in the naval architectural field, into mechanical or operating lines, with its diminution of the corps of highly trained and able young men which should be available for this work.

Annual Report of the Chief of the Bureau of Construction and Repair

According to the annual report of Naval Constructor R. A. Watt, chief of the Bureau of Construction and Repair, U. S. N., the new shipbuilding work now in progress or authorized at navy yards includes the construction of the battleship *New York* at the navy yard, New York; the construction of the collier *Jupiter* at the Mare Island yard, and the construction of the river gunboats *Monocacy* and *Palos* at the Mare Island navy yard. These two yards are the only ones fully equipped for the construction of large vessels, and it is apparent that they will be busily employed for several years to come with shipbuilding work in addition to the ship repair work which is regularly assigned to them.

The three battleships *Texas, Nevada* and *Oklahoma,* at present under contract, are building under the eight-hour law. The average price per ton of normal displacement of the three vessels in questions is $215.26 (£ ???); the average price of the preceding battleships built by contract when the hours of labor were unrestricted was $177.25 (£???) per ton of normal displacement for the three preceding, and $189.99 (£???) per ton for the five preceding vessels.

The annual report of the Chief Constructor two years ago compared the rapidity of battleship construction in this and foreign countries and demonstrated by tables that the rapidity of construction in the United States is greater than the average rate of construction in the principal foreign shipbuilding countries. Notwithstanding the recent marked increase in size of vessels, the time required for construction remains practically unchanged, and the rapidity of construction in the United States, both for battleships and destroyers recently completed without restriction as to hours of labor, continues greater than the average rate of construction in the principal foreign shipbuilding countries. The effect of the eight-hour law upon the rapidity of construction is as yet indeterminate.

The additions to the effective force of the navy by completion of vessels building under contract and at navy yards are

as follows: Battleships, *Arkansas, Florida, Utah, Wyoming;* torpedo boat destroyers, *Mayrant, Walke, Patterson, Jouett, Fanning, Jenkins, Beale, Jarvis;* submarine torpedo boats, *E-1, E-2, F-1, F-2, F-3, G-1;* colliers, *Orion, Neptune;* tugs, *Ontario, Sonoma.*

Westinghouse Telpherage System for Handling Freight at Steamship Terminals

The telphers manufactured by the Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa., present a practical means for handling miscellaneous packages, or what is known as less than carload lot freight, in railway freight terminals and transfer stations. These machines hoist, convey and lower. They can be arranged to serve every point in any given space, and can tier packages to a much greater height than is possible by hand. Freight can be transferred by them from one point to another without rehandling and with much greater speed and economy than can be done by ordinary cranes, motor trucks or hand trucks.

The telpher train runs on an elevated single-rail track, and consists of a motor-driven tractor with one, two or three trailers. Each trailer is equipped with a motor-operated hoist. The tractor motor and trailer-hoist motors are controlled by an operator stationed in the cab of the tractor.

In operation the articles to be transported are attached to the trailer hoists, or are loaded on flatboards or trucks which are attached to the hoists, as shown in the illustration. The load is then raised and conveyed to the desired point. A number of extra flatboards or trucks are used, so that they can be loaded and unloaded without delaying the telpher.

The telpher track can be arranged in a number of different ways. Where goods are to be merely transported from one point to another, as from a freight station to a warehouse, a single straight track is all that is necessary. If the telpher is to load cars in a freight terminal, a loop is run around the building, and transverse tracks, reached from the main loops by switches, are run over each platform. Where it is desired to serve every point of a given area, as in a dock or warehouse, the track consists of a loop around the building and a movable transverse track, on to which the telpher can be run over gliding switches.

A Westinghouse telpher train can carry many times the load that can be handled by a hand truck and can move six times as rapidly. There is, moreover, little or no interference between telpher trains in a properly directed installation, whereas a great deal of time is often lost with trucking on account of congestion in the aisles. The telpher train does not have to wait for loading and unloading—it deposits an empty flatboard and picks up a full one (or *vice versa*). It is obvious therefore that freight handling by telpherage must be considerably more rapid than by trucking.

The increase in the capacity of a station is effected in several ways with a telpher. In the first place the greater rapidity of the telpher tends to reduce the amount of goods stored on the receiving platforms. Secondly, where packages are tiered by hand the tiers cannot be economically made higher than 5 or 6 feet, whereas with the telpher system the height of the tiers is limited only by the clearance required by the telpher in passing over them, and in places where the telpher does not pass over the tiers they can be raised 5 or 6 feet higher. Two or three times more freight can therefore be placed on a given floor space.

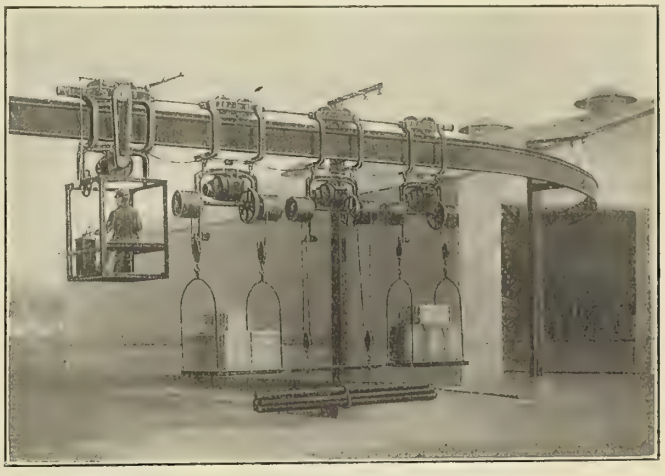
The economy of the telpher as compared with trucking is the natural result of its ability to handle large quantities of material so much more rapidly. In one test case fifteen men with telphers loaded 2,000 tons of freight in the time required for 110 men to load the same quantity by hand trucking. In general, when a Westinghouse telpherage system supersedes hand trucking the saving in the cost of handling freight, after deducting interest on the necessary investment, is from 25 to 40 percent.

With a telpherage system practically all lifting is done by the hoists. All heavy articles are hoisted separately and light articles easily handled are stacked on flatboards. Raising and lowering by means of the hoists is obviously less liable to cause injury or breakage than trucking.

A feature of the Westinghouse telpher system is the use of a separate tractor with several trailers instead of a combined tractor and carrier.

This arrangement is more economical for several reasons. There is less deadweight in proportion to the carrying capacity, and hence less power is required. When not required one or two of the trailers can be disconnected, which further reduces the deadweight.

The use of separate trailers also increases the speed and ease with which freight can be handled. In handling less than carload lots the various packages constituting a consignment must be kept together. Since the average consignment weighs 750 pounds, a full train can carry three consignments on separate flatboards. Each consignment can be loaded on a



A WESTINGHOUSE TELPHER TRAIN

flatboard, weighed, conveyed to the proper car, checked, and loaded with minimum loss of the time. When consignments consist of packages of different classifications the use of separate flatboards is even more desirable. One package after another is loaded on the flatboard and weighed, and the whole consignment is kept together.

In fact, where the tractor and carrier are a single unit it is found to be uneconomical to carry more than one consignment per trip, because of the trouble that arises from mixing consignments and the delay to the telpher occasioned by the partial unloading of the flatboards. The Westinghouse telpher train can, therefore, make three trips while the other kind is making one, which permits the work to be done with fewer telpher trains, less men, more speed, and much less congestion at the switches and loading platforms.

The frame of the tractor is a single steel casting; the wheels are double flanged. The motor drives the tractor through a silent chain and gears. A brake is applied to both wheels by turning a hand-wheel in the cab.

The cab is built of structural steel, and is so arranged that the telpher operator has an uninterrupted view of the track and the trailers. Drum controllers are mounted in the cab, one to control the tractor motor and the others to control the hoists.

The trailer trucks are similar to the tractor trucks. The suspension beams are pinned at the truck, and the hoist yoke is swiveled to the beams. Hence the load on the hoist is free to swing in any direction without tilting the truck.

The hoists are operated by motors, each of which has a normal capacity of 2 tons, a maximum full-load hoisting speed

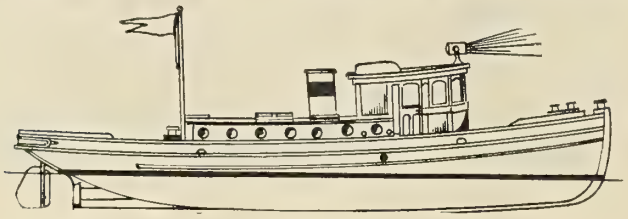
of 60 feet per minute, and is provided with sufficient cable to hoist 50 feet. Electro-dynamic braking is used for lowering. Each motor has a solenoid-operated brake, which holds the load automatically when the power is cut off. A limit switch prevents over-winding by opening the circuit and applying the brake when the hoist is raised to a predetermined point; the hoist can, however, be lowered from this point by reversing the controller.

Standard Westinghouse, 230-volt direct-current crane motors are used for both tractor and hoist units. Current is collected from single trolley with bonded trail return or from two trolleys on non-grounded circuit.

An Unusual Motor Tug Built to Do the Work of Two Steel Steam Tugs

The work which the *Natilie,* owned by the Breakwater Company, of Philadelphia, is called upon to do is probably the hardest that has ever been given to a motor boat. This is in connection with the building of a jetty at Cape May, N. J. The *Natilie* runs from Cape May to near the breakwater and picks up 150-foot barges laden with stone and tows them through the breakers and into shallow water, where they can be dumped. While doing this work the boat is often driven ashore and pounded upon the hard sand bottom. This is what she was specifically designed for, and after several months she has not shown the slightest strain. The two heavily built steam tugs used hitherto could not stand the strain of this pounding upon the beaches.

The *Natilie* is 65 feet over all, with 18 feet beam. Her least depth of hold is 6 feet 4 inches and her normal draft is



THE MOTOR TUG THAT SUPPLANTED STEAM POWER

3 feet 6 inches. She can be made to draw 12 inches more by means of water ballast. Her freeboard is 6 feet 6 inches forward and 5 feet aft.

Her framing is double sawed oak timbers 8½ inches by 8 inches, spaced 22 inches on centers. Her deck beams are each 8 inches by 8 inches and 24 inches on centers. The main keel is a solid stick of oak 10 inches by 12 inches and the main keelsom is 12 inches by 12 inches. She has four sister keelsoms each 8 inches by 8 inches, and bilge stringers each 6 inches by 10 inches. Her sheer strake is 6 inches by 10 inches.

It would seem that this framing would ordinarily be sufficiently heavy for a 125-foot steam tug, but this is not all the extra weight timber that enters into the *Natilie's* construction. She is planked with selected oak 2½ inches thick and sheathed with 3-inch yellow pine, bolted through. Her deck is of oak and pine, laid in strips 3 inches square. The oak skeg is built up tapering from 8 inches at the bottom to 14 inches at the shaft line. All fastenings are of galvanized iron, many of them being bolts set up with nuts, and every effort was made to fasten everything as securely as possible, weight of metal being disregarded to secure the maximum strength.

The superstructure is of oak and pine. The main house is but 3 feet above the deck. The floor of the pilot house is 12 inches above the deck and the height of the roof is 8 feet. Although the superstructure was kept as low as possible, head room was not sacrificed. In the pilot house there is 6 feet 6 inches and in the main cabin 7 feet 6 inches. The cabin is well arranged for the comfort of the crew, there being three staterooms, a combination galley and mess room, a toilet room and two large storerooms for hawsers, etc. There are also transoms in the pilot house that may be used as berths.

There are two watertight compartments forward and two aft, one in each end being arranged that they may be used for the storage of fresh water for ballast or to supply the steam derrick barges and other vessels of the company. The tanks have a combined capacity of 15,000 gallons.

Probably no motor boat has such a complete and powerful engine equipment as the *Natilie,* as she has all the appurtenances of a modern wrecking tug combined with the equipment of a fireboat. Her main engine is a 125-horsepower air-starting and reversing Eastern Standard engine. This engine starts, stops and reverses without the means of a reverse gear. Its operation is as simple as that of a steam engine, being done by the shifting of a lever. The compressed air is fed into the cylinders in the same manner as the gas cycle of the engine, so that one does not interfere with the other. A compressed air pump built on the engine supplies a large tank. This pump has an automatic "cut-off" device, so that when the air pressure reaches its maximum it stops pumping. When the pressure drops below normal it automatically "cuts in" and starts pumping.

The *Natilie* is also equipped with an 8-horsepower, 4½-kilowatt Standard auxiliary engine direct connected to a 110-volt generator for operating deck and running lights and a 9-inch searchlight and two electric motors. The electric outfit has a telltale system, so that if one of the running lights goes out a light flashes in the pilot house and a buzzer starts.

One of these motors operates a 4-inch wrecking pump that is equipped with 25 feet of hose, so that the tug may be placed alongside another vessel and pump her out. This pump can also operate four lines of 2-inch fire hose, taking the supply from overboard or from the fresh water tanks. Likewise the pump can be used for transferring the fresh water from the tanks to another vessel or for shifting the tank water from one tank to the other. The auxiliary engine also has an air pump which can be used as a water pump, thus giving the boat two complete pumping outfits.

The second motor is on the after deck and operates a gypsy windlass, which is another novel feature for a tug of this size. This was installed for handling the 8-inch hawsers necessary in the work the *Natilie* does. There is an unusually large iron double bitt and windlass on the forward deck and large iron bitts on each side.

For ground tackle the boat is equipped with two patent anchors, one weighing 300 pounds with 200 fathoms of 4½-inch hawser, and the other 500 pounds with 200 fathoms of ¾-inch stud-link chain. The general outfit is practically the same as that on an ocean-going steam tug.

The *Natilie* was designed by Captain I. A. Watrous, master mechanic of the Breakwater Company. She was built by M. M. Davis & Son, of Solomon's, Maryland. The Breakwater Company has just bought a 300-horsepower Standard engine of the same type as the engine in the *Natilie,* which is to be placed in service in the Hawaiian Islands.

A TYPICAL PIER FIRE.—A two-story pier in Philadelphia, Pa., owned by the Baltimore & Ohio Railroad, and used by the Hamburg-American and Italian steamship lines, was completely destroyed by fire early in October. The inaccessible location of the pier and the lack of automatic fire protection were responsible for this disaster. Other cases where fires have started in a similar manner on steamship piers are not infrequent, but where the pier is equipped with an automatic sprinkler system it has been found invariably that the fire was promptly extinguished before it had gained sufficient headway to cause more than trifling damage. Such a disaster is a strong argument for the immediate adoption of a reliable automatic sprinkler system on all steamship piers as a protection against fire.

Towboat Narragansett, General Utility Boat

The towboat *Narragansett,* recently completed by the Atlantic Works, East Boston, Mass., was built for the Staples Transportation Company, of Fall River, Mass., as a "general utility" boat. She is intended primarily as a harbor and bay towboat, but has ample power, coal and water capacity to engage in coastwise towing; in addition, she is equipped as a fire, wrecking and water boat, and the hull was designed and constructed with the object in view of making her very efficient as an ice breaker.

The boat is 100 feet long, 24 feet 6 inches beam, and 12 feet 9 inches deep, and, with bunkers and tanks filled, draws 11 feet 6 inches aft and 9 feet forward. The frame and planking are of white oak, the planking being 3 inches thick, the keelsons, ceiling and beams are of yellow pine, and the deck of Oregon fir. The hull is salted from a point 2 feet below the waterline to the deck. She has a Hyde Windlass Company combination hand and steam steering gear, the steering engine being placed on the main deck in a recess at the after end of the engine room, with a small steering wheel fitted on the top of the deck house at the after end for convenience in handling the boat when docking vessels, etc. A Hyde steam capstan for handling hawsers is fitted at the stern.

HARBOR TUG EQUIPPED AS A FIRE, WRECKING AND WATER BOAT

The deck house has the usual galley and messroom at the forward end, with two staterooms about amidships for the engineers, and a spare stateroom aft, the captain's stateroom being directly aft of the pilot house and the crew's quarters in the forecastle.

As it is necessary at times to send this boat into shallow harbors, the hull was so designed and balanced that by pumping water from the after tanks to the forward tanks, and by admitting sea water to the forepeak, the boat can be brought to a draft of 10 feet or less forward and aft, an ejector being fitted to discharge the water from the forepeak overboard when the boat is to be returned to her normal trim.

The machinery consists of a fore-and-aft compound, surface-condensing engine having cylinders 14 inches and 32 inches diameter by 24 inches stroke, and develops 450 horsepower in service conditions. The engine is of the open front type with cast iron back columns and forged steel front columns, the condenser being independent of the engine frame. The high-pressure cylinder has a piston valve, and the low-pressure cylinder has a double-ported slide valve with counterbalance cylinder. The engine has steam reverse gear, and an adjustable cut-off consisting of ratchet teeth on the end of the connecting rod of the reversing cylinder, with a pawl that can be engaged with the ratchet teeth, thereby shortening the travel of the valves. When the engine is reversed the pawl falls out by its own weight and the valve gear then goes to the full travel, ahead as well as astern. The regular throttle and reverse levers are fitted in the lower engine room, and another set of levers is also fitted in the upper engine room, so that when docking vessels and doing similar work the engineer can handle the engine from the upper grating.

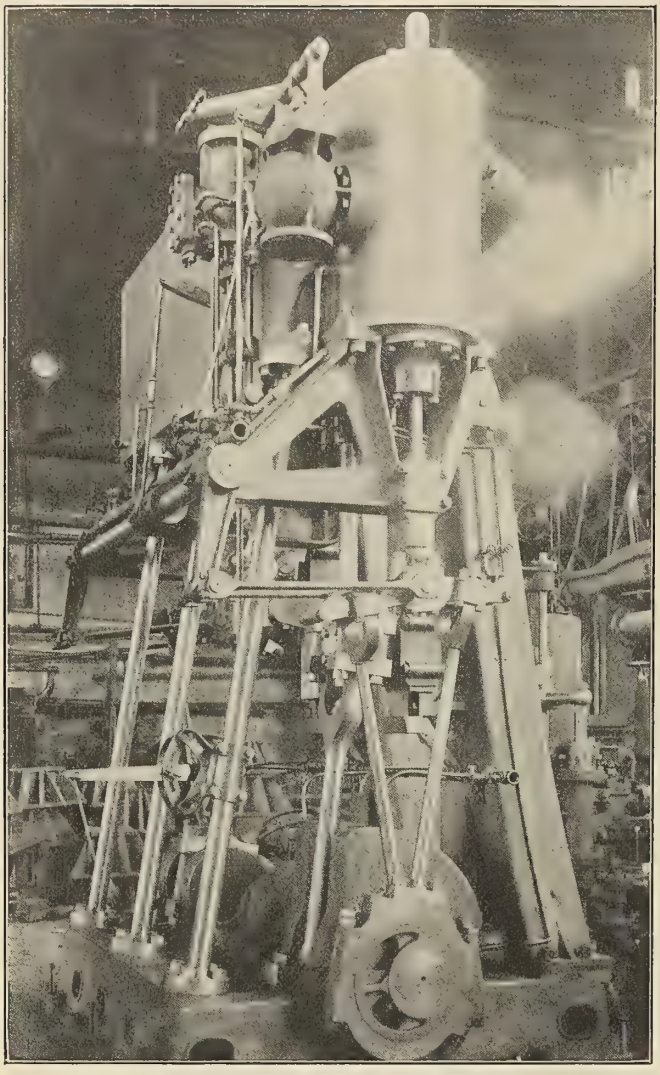
The boiler is of the Scotch type, 12 feet diameter by 11 feet long, having three removable Morison suspension furnaces, and has 60 square feet of grate surface and 1,600 square feet of heating surface, the working pressure being 165 pounds per square inch.

The circulating pump, air pump, boiler feed pump and bilge pump are connected to the main engine, and are worked by a beam from the low-pressure crosshead. The connected feed pump is of smaller capacity than would normally be fitted to an engine of this size, in order to prevent the feed pump drawing all the water from the hot well when the engine is running at slow speed, and a small independent steam feed pump is fitted, this pump being regulated by a float in the filter box so as to handle the balance of the feed water and maintain a suitable level of water in the hot well.

The boat is provided with an efficient fire pump having four hose connections on the side of the house, this pump also having a deck suction so that it can be used as wrecking pump. A closed feed water heater is fitted, the heater taking steam from the low-pressure receiver, and also the exhaust steam of the feed pump. The thrust is of the horseshoe type running in an oil bath.

The coal bunkers have a capacity of 50 tons, stowed in an athwartship bunker having a coaling trunk extending to the top of the deck house, and in side bunkers with the usual bunker deck plates. An ash ejector is fitted in the fireroom.

A small steam pump is also installed, which is used only for pumping fresh water, the suction being connected to the tanks, with a discharge on deck, so that the boat can be used when



MAIN ENGINE OF THE NARRAGANSETT

required as a water boat for filling the tanks of barges and other vessels.

The question of speed was not given special consideration in designing this boat, but on her trial trip, which was made at Boston, September 23, 1912, she made about 12 knots, which was very satisfactory to all concerned. The boat and engine are shown by accompanying photographs.

Triple-Screw Motor Ship Alkmaar

BY J. RENDELL WILSON

Recent developments of the marine Diesel engine have brought to light the fact that there are about thirty different motors of the semi-Diesel, or low compression heavy oil-consuming type, constructed by various firms on the Continent of Europe and in the British Isles. In America there is the Mietz & Weiss. The engines are of great interest, and deserve better attention than they have received in the past, as, like the Diesel, they use low grades of kerosene (paraffin) or residue oil as fuel—although not quite as heavy oils as the Diesel. With the latter the fuel is burned at constant pressure, whereas the semi-Diesel requires a hot bulb for the purpose of vaporizing and firing the oil. Both four-stroke and two-stroke cycle engines are on the market.

An interesting passenger vessel driven by three semi-Diesel engines has just been placed in service on the river Zaan, between Amsterdam and Alkmaar, by the Alkmaar Packet, Ltd. She has been built by the Nederlandsche Scheepsbouw Maatschappy, of Amsterdam, and is of the shallow draft class with three decks, and has a capacity for nearly 1,500 passengers. *Alkmaar,* as the vessel is named, is 134 feet 6 inches long over all, and 128 feet between perpendiculars, by 25½ feet extreme beam, 24 feet 5 inches waterline beam. The depth from keel to the upper deck is 33 feet 6 inches, while her draft is under 6 feet. It is interesting to note that a steam vessel of her dimensions to carry the same number of passengers would have a draft of about 8 feet, which in this case is impractical, as the river Zaan is not more than 7 feet deep.

Her accommodation arrangements are as follows:

Under the first deck the forepart is given over to the first class saloon, which is finished in old oak with Delftware cosy corners, toilet rooms, etc., while the second class is aft of this space. On the first deck the first class quarters are also forward and the second aft. Right forward on the second deck the steering apparatus has been installed, aft of this a first class saloon finished in Louis XV style and a second class saloon aft. The third and upper deck is well provided with seats for first and second class passengers. Several glass screens are placed to protect passengers against the wind. Altogether there is seating accommodation for some 1,000 people, but, of course, many more can be carried.

Special care has been given to the steering gear arrangements, as no steam is available, and a motor-driven gear was considered too complicated. The wheel is connected to the rudder by a shaft supported in ball-bearers working an eccentric gear wheel, which moves an oval quadrant, fixed at the rudderhead. This arrangement, very cleverly thought out, renders it quite possible for one man to turn the rudder hard over even when running at full speed.

Her machinery consists of three two-cylinder Kromhout engines, constructed by Messrs. D. Goedkoop, Jr., of Amsterdam, each developing 90 brake horsepower at 280 revolutions per minute on the two-stroke principle. They are of the single-acting, non-reversing type, and each turns a 4-foot 1-inch diameter propeller through a reverse gear.

The system of operation is quite simple. On the down or explosion stroke, scavenging air is compressed in the crank case and is admitted to the cylinder through ports just before the completion of the stroke. On the upward stroke the air is compressed to about 200 pounds into a lamp-heated bulb, or special combustion chamber, and immediately before it reaches its highest point fuel is sprayed in through a valve from a small plunger pump, one for each cylinder, and combustion instantly occurs. The lamps are needed only for starting, as once the engine is well going the heat of the explosion maintains the bulb to a red heat.

In the engine room there also is a single-cylinder Kromhout engine driving a dynamo for electric lighting, and operating the bilge and general system pumps. Each main engine is equipped with a water-cooled silencer and the exhausts are led to a big silencer in the funnel. At the after end of the engine room is a platform where the reverse gear levers and engine controls are arranged, allowing the entire machinery to be maneuvered by one engineer. Starting is by compressed air, obtained from the explosions in the engine cylinders and stored in three large reservoirs.

The *Alkmaar's* official trials were run on October 5, and the following day she commenced her regular service, which probably constitutes a record for a vessel of her class. The voyage from Amsterdam to Alkmaar occupies between three and three and one-fourth hours, the average fuel consumption for this period being 28.5 gallons. During the trial trip an average speed of 10.6 knots was maintained, and with a full load of fuel on board with a displacement of slightly over 200 tons 11.6 knots were made.

Letters from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

A Broken Condenser Baffle

When the writer first went to sea the chief engineer under whom he served insisted upon a rigid course of inspection of all parts of the plant at each end of the run. In a log book was listed all parts, and each part as inspected was ticked off, so that at the end of the run we would take up the work where we left off. And hence all details were constantly inspected with regularity, and while it involved a lot of work yet it amply repaid. It is not always the large parts that cause trouble; very frequently it is the very small detail that causes trouble.

On a new dredge working in Southern waters, there was trouble caused by a part that one would give the least attention to. This dredge was equipped with a triple-expansion engine, the condenser of which was separate and had independent air and circulation pumps. The circulator was, of course, placed in the lowest point of engine room, while the lower tubes of the condenser were on a line with the deck. On several occasions the circulator had slowed down, but the condenser did not get very warm, as it was discovered in time. One night as the second engineer was going on watch, he passed through the fire room, and noticed that the water-glass was showing three-quarters full. It was their practice to run with about 2 inches level in the glass. On reaching the engine room he noticed that water was running from the hot well overflow. He called the first assistant engineer's attention to this condition. The first assistant did not wait to be relieved, but was up in the messroom. When informed of the fact that something was wrong he turned to the second assistant, with the remark, "You know what to do, don't you?"

The second then reported to the chief, who stated that he would come below shortly. The second then notified the lever man that he intended to shut down and for him to clean his pipes. It is customary on suction dredges to wash out the pipes before shutting down the pumps, and as these pumps were direct-driven from the main engine, the whole plant would be shut down. The boilers were cooled and blown down to get the water down to the proper level and density. By the time the chief arrived all the tackle was up ready to handle the condenser bonnets and all the nuts removed. Upon removing the bonnets a couple of tubes were found to be leaking very badly, but a slight split in the tubes would hardly account for all the water. Well, the surprise was yet to come, for upon getting hold of the tubes only one-half of each was withdrawn. The tubes had been cut in two, and only two tubes were causing trouble. After the remaining halves were removed, and the tube plate holes plugged with ½-inch pipe plugs, the condenser was closed up and the engines were again started.

The following day the engines were again shut down to determine the cause, as this was a mystery that remained to be solved, because salt water could only get into the feed line or from the hot well through condenser leaks. The eduction pipe to the condenser was removed, and upon looking into the condenser the cause was discovered. The baffle plate, short at best, was broken in two, and hence every pulsation raised and lowered the halves, and they impinged upon two tubes only, and resulted in cutting them in two. The baffle plate was cracked as though it had been heated and plunged into cold water with resulting cracks, but the edges of the separated sections made a fine chisel. The boiler, feed heater and line were beautifully coated with salt and the bilges were filled. How it ever escaped the notice of the first assistant engineer's attention is a matter he will have to explain to others from whom he seeks employment.

A new baffle plate was sent from the shop with slight modifications. It was simply the regulation size baffle. They have been made, I believe, one size ever since surface condensers were used, and that size is as small as possible. No doubt it would hurt the feelings of designers to make them long and well supported, because they only baffle exhaust steam, and hence fill the bill. A baffle plate should be long and well supported, for the action of the exhaust steam causes constant flexure, and of course painting is not conducive to the life of the metal, and from this fact alone a baffle plate should be designed to withstand the strains set up. The new baffle plate was installed and work resumed. Of course, the machinery was in operation without one until it arrived. How long it will last it is hard to say. The loss of time, with its consequent financial loss, is not a small matter, for, as a rule, a dredging company figures on a dollar a minute loss for every minute the dredge is idle when working on a station, and it takes but little consideration to see that this is not overrated.

There was another very peculiar condition obtaining on this dredge. It appears when carrying the water about three-fourths glass full the engine worked dry steam, and when carried about 1 to 1½ inches in the glass the steam was very wet. There was a separator in the steam line, and when the engines were working wet steam a sample taken from the well of the separator was very dry, say about .97 dryness fraction, or, in other words, it did not contain over 3 percent moisture, and 0.97, I think, is placing it lower than it ever obtained. There is a reason for this, and I leave it to your readers to solve it.

It is only again a case of taking care of the first cost and permitting the builders to furnish anything and any arrangement that suits their ideas. The owners, however, are going to pay for this kind of work, as a naval architect's and marine engineer's time is too costly, but by the time these conditions are overcome his services would be a very small outlay compared to their bills, caused by inferior design and construction. The writer at some future time will have more to say on the arrangement of machinery, boilers, heaters, etc., of this type of non-propelling dredge. CHARLES S. LINCH.

Patching a Boiler

The following is an account of a breakdown that occurred under trying conditions when I was chief engineer of a Greek steamer. I took on a contract to take the steamship *Spiridon* from Cardiff to Constantinople, the vessel having been purchased by a Greek company from a South Wales company. Two days after I signed the contract we had to put to sea without my being able to thoroughly examine the multitubular boiler, which had been out of commission for three years. We left Cardiff on the morning of October 14 and experienced terrific seas in the Bay of Biscay. My assistant and I were kept imprisoned for three days, and had our food lowered down the after ventilator by the cook, whose galley was within reaching distance.

After having been awake for the most part of the time I lay down on a locker exhausted, and then slumbered only to be awakened in a few minutes by a terrific report, which

seemed to shiver the ship from stem to stern. The two firemen rushed up the ladder, and had to be brought below again by divers threats. My assistant, when he could find me in the midst of a scalding, seething steam, shouted that he thought the circumferential seam had "started" on the bottom of the boiler.

It did not take long to find out that something more serious than a seam had gone, for the water in the gage glass was dropping very rapidly. I ordered the fires to be drawn out—there was nothing else for it. We tried to keep the boiler full with the pumps, but that was useless.

As soon as the boiler emptied (it took seventeen minutes only) I crawled under the boiler and found near the circumferential seam at the front end a hole about 1 inch by 1½ inches and for a radius of about 2 inches the plate was very thin.

We looked around the engine room and found two pieces of plate ½-inch thick, 3 inches by 2½ inches. One piece we heated and "stepped" to fit into the joint of the seam on the inside, and the other simply curved to the sweep of the shell on the outside. Through the centers of these plates we drilled 1-inch holes. Two joints of asbestos cloth were cut and a 1-inch bolt passed through the plate on the inside and through the boiler shell and the outside plate, leaving the nut on the outside to facilitate screwing up tightly. To make doubly sure, we made some cement and covered up the inside plate about ½-inch thick and allowed it to set.

From the time the engines stopped to starting up again occupied exactly fourteen and one-half hours, and there were only three of us doing the work. Eight days after this we arrived in Turkey, having carried a full head of steam (135 pounds gage.) F. CHRISTIANSEN.

New York.

A Good Way to Block the Ports in a Steam Chest

On the way up the California coast a serious accident occurred which seemed wonderful in that no one was hurt. When making the necessary repairs it was also of interest to see how useful was the advice of a man who was supposed to know nothing of the trade. The motive power consisted of two triple expansion engines with four cylinders, the arrangement being forward low-pressure, high-pressure and intermediate-pressure, and after low-pressure. The engines were of the inverted type, with a combined power of 16,000 horsepower.

Everything was moving along nicely at 70 revolutions when something let go in the port high-pressure cylinder with three hard thumps and a lot of that sickly tearing and ripping of breaking material that sounds so terrible to those that have been unlucky enough to have been present at such accidents. But what the trouble was no one ever knew, as the steel piston was so bent and distorted that it was impossible to form an accurate idea of the cause, more than to guess that the follower bolts became crystallized and let go, as the bolts, follower and piston packing were all minced. The head was broken in thirteen pieces, the cylinder split down the side in four places for 30 inches, tearing away from the lugs that bolted to lugs on the forward low-pressure cylinder.

The throttle was closed at the first crash and the reversing gear thrown over, stopping the engine within eight or ten revolutions. It was phenomenal that none of the broken pieces from the head or cylinder fell on the man at the throttle, as the throttle was at the side and directly under the high-pressure cylinder, and the man stuck to the throttle until the engine was stopped.

The starboard engine was started up to 100 revolutions to take care of the steam. The port engine was secured, the jacking worm put in and the vessel kept on at nearly her standard speed without stopping until the next port was made. There the port high-pressure piston rod was fastened up with a strong back, the connecting rod removed, the valve gear disconnected and the valve placed to cover the ports, as neither the valve chest nor its steam connections had been damaged.

But so much steam got by the valve into the broken cylinder that the valve was removed and the ports were blocked with wedges and Portland cement and the engine put in use again. The wedges leaked, however, so that very little pressure, only 18 to 20 pounds, could be carried on the intermediate-pressure receiver and make it possible to live in the engine room.

When the next port was reached the wedges were removed and new ones were being put in with the hope of better luck. While this work was proceeding the coppersmith came up to see what the inside of a steam chest looked like, and after watching the process of putting in the wedges for a while and understanding what was wanted, made the remark that he could fix that in a very short time so that it would be tight, and while not thinking that he could improve on the method that was being employed he was asked to explain how he could repair the job.

His way was to take some ⅛-inch copper sheet that was on board, make a ring a little longer than the port and the diameter of the chest, braze the seam, annéal same, and when in place peen the ring out so as to fill the zigzag openings of the port and make the ring fit tightly 1 inch above and the same below the openings.

This sounded very nice and the wedges were removed and the coppersmith set at work. He finished the job in eight hours. The chest cover was replaced, the stuffing box for the valve stem plugged, and the vessel on her next trip ran compounded with a receiver pressure of 110 pounds on the intermediate-pressure valve chest without a weep of steam coming through the covered ports. The vessel made 3,000 miles under these conditions before another cylinder was cast and made ready to replace the broken one. When the vessel went to the shipyard for the installation of the new cylinder the shipyard company took photographs of the old cylinder, showing how the copper rings were placed, and highly complimented the ship's engineering force on the neatness and effectiveness of the repairs, and it was all due to the advice of a man that, out of curiosity, took a look to see what the inside of a steam chest looked like, and of whom no one expected anything in the way of repairing engines.

I might add that this cylinder was heavily lagged with the ordinary asbestos lagging, which no one would consider as dangerous; but when the cylinder carried away, the asbestos was thrown in every direction and making such a dust that it was impossible to see a distance of more than two feet from where one stood. This lasted for several minutes, besides affecting the eyes badly and adding greatly to the confusion when things had to be done quickly. READER.

Fitting a New Cylinder Liner

The following is an account of how we fitted a new liner to one of the cylinders of the main engines of the old *Triumph,* while she was on the Pacific station, and although it is an old story it may be of interest to readers to-day:

It fell to the duty of the writer to line up the piston of the engine in question, when, after pulling the spring ring back so as to clean underneath it, I noticed a mark in the bottom of the cylinder, which on closer examination proved to be a crack about 5 inches long. Of course, I at once reported the same to the senior engineer, who, by the way, was an engineer in every sense of the word. Well, I marked the crack at each end, and after closing up we went outside Esquimault harbor for target practice; when we got back into harbor again, after about twelve hours' steaming, we found the crack had extended about 3 inches at each end. We then tried plugging the crack at each end with cast iron plugs, but after steaming

again for a short time we found the crack still extending. Our chief then decided not to steam again with the old liner in. After getting the sanction of their Lordships we sent home to a well-known firm for a new liner, and after getting the old one out and landed on shore out of our way, the new one arrived at Victoria, B. C., on the same day that we landed the old one. We soon had the new liner out of its packing case, and I do not know what made our chief engineer think of it, but he asked me to measure it to see how it corresponded with a gage which I had made to the cylinder casing, when, to our utter dismay and astonishment, we found it to be 3/16 inch too large. How in the name of fortune such a firm could have made such a mistake passes my comprehension, for we had sent them a good gage made out of 1¼-inch round iron; besides, they had the drawings of the engines to guide them. However, there was the fact staring us in the face, and an unpalatable fact it proved to be.

Now, let me here lay to rest a myth that was in vogue about the job I am about to describe, and that is the one about using the capstan as a vertical lathe. That yarn was sheer nonsense. What we did was this, for that liner had to be turned down to size. A strong timber platform was erected in the engine room, and the liner stood on this on its end. We then made a tool and tool-box with the necessary adjusting screws, and got the heaviest shot we carried in the ship to steady the tool-box. The stokers were then turned to to drag the tool round the liner, the writer of this standing at a fixed point to put the feed on after each revolution.* In this manner the surplus metal was taken off in three cuts. The liner was fixed and stationary. I think my readers will agree that for a turning job it was a creditable performance. Rigging the job and making all the appliances for same was only one of the many obstacles we had to overcome, for the great difficulty was to keep the liner in shape, for it warped and buckled in all directions. Wooden "shores" were placed inside at all available spots; these rendered the necessary trammeling an awkward job indeed. However, the job was at last completed so far as the machining was concerned. When we got it into position we found, to our joy, that it was a rattling good fit, for we had to force it with "jacks" for the last 6 inches of its getting home.

There is a point that I should refer to, for it goes to show what an amount of extra work can be entered into through neglecting to take wise precautions against errors. When we got the old liner out, rough templates were made to the bolt-holes in the cylinder. On taking the template on shore to finish it, it was applied to the old liner, and was found to be ⅝ inch out by comparison. This puzzled us, for great care had been exercised in making the template. The old liner was lying on its side when the template was applied to it, and on calipering it we found that it had sagged by ⅝ inch. Then the old performance of shoring it inside had to be carried out again before the template could be finished.

It took just seven months from the time we started pulling to pieces until we had our steam trial. During that time we had the loan of one fitter E. R. A. from another ship, which brought our working staff up to three fitters, one blacksmith, one coppersmith and two boiler makers.

We read of many troublesome breakdowns being repaired at sea, and under most trying conditions, but the writer questions whether ever, in the history of marine engineering, a similar job to the one described was ever carried out so successfully away from all the appliances of a dockyard workshop. Our senior engineer, who, by the way, was a splendid officer, was given two years' seniority for his share—and it was a big one—in the creditable performance; while the writer of these recollections was informed that their Lordships were pleased to promote him to a Chief E. R. A., a promotion that was much appreciated, considering the conditions under which the work was done.

Such are the bare outlines of how we turned down and fitted a new cylinder liner to H. M. S. *Triumph's* engines. I omitted to mention that when under steam the liner was perfectly tight and gave no further trouble.—*From an ex-Chief E. R. A. in The Artificers' Review.*

* It should be noted that the internal diameter of the cylinder was 78 inches, and it had five fitting strips on its outside.

Design of a Crank Shaft

In response to an inquiry the following is given to show the method for designing a crank shaft to fulfill the conditions stated herein:

Four-cylinder, triple expansion engine of 8,250 indicated horsepower.

Cylinder diameters, 32, 53, 61 and 61 inches.

Stroke, 48 inches.

Revolutions per minute, 120.

Piston speed, 960 feet per minute.

Steam pressure at engine, 250 pounds.

Length of bearings, 20 inches.

Distance between centers of bearings, 60 inches.

The diameter of a solid shaft and the inside and outside diameters of a hollow shaft are desired for this engine.

The allowable working stress for the shaft will depend upon the type of engine. If it is a naval engine which will develop the maximum power during only a small part of the engine's life, a much higher working stress can be allowed than if the engine is for a merchant vessel where the maximum power is to be developed all the time.

If we are dealing with a naval engine the steel for the shaft will probably have an ultimate strength of 95,000 pounds per square inch, and we can use a working stress of 9,000 pounds per square inch at maximum power. If we are dealing with a naval engine to work continually at full power, it will be better to use a working stress of 7,500 pounds per square inch. In the case of an engine for a merchant ship the steel will probably have an ultimate strength of 75,000 pounds to 80,000 pounds per square inch, and a working stress of 6,500 pounds per square inch will be permissible.

The mean twisting moment upon the section of shaft aft of the fourth cylinder will be

$$\frac{8{,}250 \times 33{,}000 \times 12}{2\pi\, 120} = 4{,}330{,}000 \text{ inch-pounds.}$$

The maximum twisting moment will be about

$$1.25 \times 4{,}330{,}000 = 5{,}420{,}000 \text{ inch-pounds} = T.$$

The force acting to bend this section of shafting will be practically the same as the force acting to produce the maximum twisting moment, or

$$\frac{5{,}420{,}000}{24} = 225{,}500 \text{ pounds.}$$

We can assume the bending moment to be given by the formula

$$B = \frac{W\,l}{8} = \frac{225{,}500 \times 60}{8} = 1{,}690{,}000 \text{ inch-pounds.}$$

The twisting moment which will produce a stress equivalent to that produced by the combined twisting moment and bending moment is usually found by means of the formula,

$$T_1 = B + \sqrt{T^2 + B^2}$$

$$T_1 = 1{,}690{,}000 + \sqrt{(5{,}420{,}000)^2 + (1{,}690{,}000)^2}$$

$$= 7{,}365{,}000 \text{ inch-pounds.}$$

The diameter of the shaft to stand such a twisting moment can be found from the relation,

$$p = \frac{T_1\, y}{I_p}$$

p = stress in pounds per square inch upon extreme fibers.
y = distance from neutral axis to extreme fibers.
I_p = polar moment of inertia.

The expression for the polar moment of inertia of a solid circular section is

$$I_p = \frac{\pi D^4}{32};$$

and for a hollow circular section,

$$I_p = \frac{\pi (D^4 - d^4)}{32}.$$

D = outside diameter of shaft.
d = inside diameter of shaft.

If $d = c\,D$, then $I_p = \frac{\pi D^4 (1 - c^4)}{32}$

Solid shafts,

$$p = \frac{T_1 y}{I_p} = \frac{T_1 \frac{D}{2}}{\frac{\pi D^4}{32}} = \frac{5.1\,T_1}{D^3}$$

Hollow shafts,

$$p = \frac{T_1 \frac{D}{2}}{\frac{\pi D^4 (1 - c^4)}{32}} = \frac{5.1\,T_1}{D^3 (1 - c^4)}$$

Therefore for solid shafts,

$$D = 1.72 \sqrt[3]{\frac{T_1}{p}};$$

and for hollow shafts,

$$D = 1.72 \sqrt[3]{\frac{T_1}{p\,(1 - c^4)}}$$

If the inside diameter of the shaft is half the outside diameter, then $c = .5$ and $(1 - c^4) = .9375$.

If $c = .6$, then $(1 - c^4) = .87$.

In the present case the sizes of solid shafts for the various conditions would be as follows:

For a naval engine developing the maximum power for short intervals,

$$D = 1.72 \sqrt[3]{\frac{7{,}365{,}000}{9000}} = 16.1, \text{ use } 16\tfrac{1}{8} \text{ inches};$$

For a naval engine developing the maximum power continually,

$$D = 1.72 \sqrt[3]{\frac{7{,}365{,}000}{7500}} = 17.1, \text{ use } 17\tfrac{1}{8} \text{ inches};$$

For a merchant ship engine developing the maximum power continually,

$$D = 1.72 \sqrt[3]{\frac{7{,}365{,}000}{6500}} = 17.92, \text{ use } 18 \text{ inches}.$$

When hollow shafts are used with the inside diameter equal to one half the outside diameter, the sizes for the three cases will be as follows:

Outside diameter $= D = 1.72 \sqrt[3]{\frac{7{,}365{,}000}{.94 \times 9{,}000}}$
$= 16.42$, use 16 7/16 inches,
Inside diameter = 8 3/16 inches;

Outside diameter $= D = 1.72 \sqrt[3]{\frac{7{,}365{,}000}{.94 \times 7{,}500}}$
$= 17.4$, use 17 7/16 inches,
Inside diameter = 8 11/16 inches;

Outside diameter $= D = 1.72 \sqrt[3]{\frac{7{,}365{,}000}{.94 \times 6{,}500}}$
$= 18.3$, use 18 5/16 inches,
Inside diameter = 9⅛ inches.

It will be noticed that the diameters of the hollow shafts are only 5/16 inch larger than those of the solid shafts.

Ann Arbor, Mich. EDWARD M. BRAGG.

Disastrous Accident to a Beam Engine

After a strenuous season steamboating on the St. John River, we are now in winter quarters and have more leisure time to read and compare notes of the season's breakdowns. The following perhaps will be of interest to some of the readers of INTERNATIONAL MARINE ENGINEERING, especially those old warriors of the beam engine type:

The passenger and freight steamer *D. J. Purdy*, operating on the St. John River, is fitted with a beam engine with a cylinder 32 inches diameter by 96-inch stroke, with Sickles valve gear. Steam is supplied at 55 pounds pressure per square inch by two leg boilers. The paddle wheels are 19 feet 6 inches diameter with feathering floats. The normal speed is 33 revolutions per minute with the engine operating on a vacuum of 27 inches.

We left our wharf at ten A. M., the machinery working as usual, when about three miles from the wharf the walking beam (which is of solid cast iron weighing about 2,600 pounds) snapped off at the air pump lever pin without any warning. On examination it was found that the piston was in five pieces, the piston rod bent 3 inches out of line, the cylinder cover in four pieces, the division plate between the bottom of the cylinder and the condenser in countless fragments, the guide rods sheared from their position, the broken end of the beam swung around, carrying away the top dash-pots and steam and exhaust valve stems. Fortunately, none of the 200 passengers or crew aboard was hurt. The engine and boilers had just been under a rigid inspection of the Dominion boiler inspector.

It appears that four years ago there was placed in the bottom of the cylinder a cast iron piece 32 inches diameter by 1 inch thick to reduce the bottom clearance of the piston. This was fastened by four ¾-inch studs screwed into the division plate with a cast iron piece dropped over the studs and the ends of the studs riveted over. This cast iron piece was found cracked across the steam port opening, one-half being in place, the other half forced up on end (by the steam rushing through the port) and driven through the division plate on the down-stroke of piston.

When repairing the damage the cast iron piece was omitted, with the result that the knock, which was one of the peculiarities of the engine for years, disappeared entirely when the original piston clearance was allowed. Had this cast iron piece been securely and mechanically fastened in the first place, this serious breakdown that endangered the lives of the passengers and crew would not have occurred. Since repairs were finished the engine has given the best satisfaction.

St. John, N. B., Canada. JOSEPH WILLIAMS.
Chief Engineer, S. S. *D. J. Purdy*.

CONVENTION OF NATIONAL MARINE ENGINEERS' BENEFICIAL ASSOCIATION.—The thirty-eighth annual convention of the National Marine Engineers' Beneficial Association of the United States will be opened at 9 A. M., Jan. 20, at the New Charleston Hotel, Charleston, S. C.

Marine Articles in the Engineering Press

Greek Torpedo Boat Destroyers Lion, Panther, Hawk and *Eagle.*—These vessels, built by Cammell Laird & Company, Ltd., to the order of the Argentine Government, and subsequently purchased by the Greek Government, have a length of 285 feet, a breadth of 27 feet 7 inches, a depth of 17 feet 6 inches, and a draft of 9 feet in trial condition when carrying a load of 195 tons, the displacement being about 1,050 tons. The mean speed for six hours' continuous steaming was 32.2 knots, the propelling machinery consisting of independent compound impulse and reaction turbines of the Parsons type, arranged on two shafts, each turbine being in a separate engine room. No cruising turbines are fitted, but special nozzles are provided to the ahead turbines to obtain greater economy at cruising speeds. Five Yarrow boilers, fitted with oil-fuel burners of Messrs. Babcock & Wilcox design, furnish steam. The total bunker capacity is 250 tons of coal and 90 tons of oil. The armament consists of four 4-inch quick-firing guns, placed on the centerline of the vessel, and four 53-cm. torpedo tubes. 9 illustrations. 1,200 words.—*Engineering,* November 8.

Fuels for Internal-Combustion Engines.—A comparison is made between crude petroleum and producer gas as fuels for internal-combustion engines. The point is made that suction gas is not only more economical to run but that it is much cleaner. Anthracite coal, coke or charcoal may be used in the producer, the kind of fuel having a marked influence upon the cost of power production. Installations of marine suction gas producers, as furnished by various builders, are described. The types of boats in which such installations have been eminently successful are described, together with some discussion as to the cost of installation and operation. 7 illustrations. 2,900 words.—*The Marine Engineer and Naval Architect,* October.

Ramsay Patent Marine Governor.—The Ramsay governor is a device designed to prevent racing of marine engines. It is anticipatory in nature; that is, it operates before racing can take place, and this anticipating movement of the governor can be adjusted in a few seconds to any degree of delicacy that may be considered necessary to suit the trim of the ship. The throttle valve of the engine is operated by an atmospheric power cylinder and piston. The piston valve is operated by an arm carried by a tiltable tube containing a certain amount of mercury. This tube is placed fore-and-aft in the engine room, and the flow of the mercury in the tube as the ship pitches acts as a lever to open and close the valve. 2 illustrations. 1,700 words.—*The Steamship,* October.

The Italian Tug Boat Savoia With Diesel Engines.—The tug boat *Savoia,* built by the Cantieri Officine Savoia, Cornigliano Ligure, Italy, and propelled by a Diesel engine, has the following dimensions: Length between perpendiculars, 98 feet; main breadth, 19 feet 8 inches; depth, 9 feet 2 inches; draft, loaded, 6 feet 3 inches; corresponding displacement, 170 tons. The engine has four cylinders, developing 280 shaft-horsepower; it is of the Savoia type, two-cycle, single-acting, working on the Diesel principle, with two scavenging pumps driven by the crank shaft. Two drawings and one photograph. 350 words.—*Engineering,* December 6.

Salvage and Fire Tug San Gerrano.—Messrs. Merryweather & Sons, Greenwich, have recently built for the Societa Anonima Bacini e Scali Napoletani, Naples, the tug *San Gerrano,* to serve as a harbor tug and for fire protection of the port; it is also capable of undertaking salvage work on a large scale. The vessel is 114 feet long, with a beam of 19 feet and a draft of 8 feet. It is divided into six watertight compartments. The propelling engines are of the triple expansion type of 500 indicated horsepower, giving the boat a speed of 10 knots. Steam is furnished by three boilers, one of the Scotch type sufficiently large to provide steam for the propelling engines at full power with natural draft, and coal fuel, and two of Messrs. Merryweather's vertical marine watertube boilers, capable together of performing the same duty. The latter are, however, fitted for liquid fuel and are operated with forced draft. The pumping installation is said to be the most powerful ever fitted to a vessel of this class. It comprises two centrifugal pumps, driven by vertical inclosed steam engines with forced lubrication. Each pump has a rated capacity of 700 tons per hour. In addition there are two double-cylinder, vertical direct-acting pumps, each of a capacity of 545 tons per hour working against a head of 300 feet. These are provided for fire duty. The total combined pumping capacity for salvage work is thus 2,490 tons per hour, and for fire purposes 4,000 gallons per minute. Five photographs. 620 words.—*Engineering,* November 15.

The Motor Ship Juno.—This article is a critical discussion of the construction and arrangement of the Diesel engine built by the Nederlandsche Shipbuilding Company of Amsterdam for the motor ship *Juno,* built by the same company for the Anglo-Saxon Petroleum Company. The ship is 258 feet long between perpendiculars, 45 feet molded breadth, 18 feet 6 inches draft, and displaces 4,300 tons with 2,675 tons of deadweight. The engine is of 1,100 horsepower, giving the vessel a speed of 10.5 knots. The *Juno* is compared with the *Vulcanus,* the pioneer Diesel engine ship, built by this company for the same owners, bringing out in detail the facts concerning some of the happenings to the *Vulcanus,* which were hitherto unexplained. The engine for the new ship differs considerably from the engine of the *Vulcanus,* and the author criticises quite severely the framing of the engine as being too light and insufficient for the purpose. Other alterations in the design noted are the method of driving the cam shaft, which is explained in detail, the abandoning of forced lubrication, the use of water in place of an air blast for cooling the cylinders, the simplification of the valve gear, the rearrangement of the air inlet to reduce the noise, the remodeling of the fuel feed system, which appears to meet with thorough approval, and the installation of small tanks for supplying solar oil to be used in connection with Tarakam to overcome its defects. The article then describes in detail the operation of the engine. All of the auxiliaries which are required to be at work while the engine is at sea, with the exception of the water circulating pump for the condenser, are driven off the main engines. The other auxiliaries consist of a 100 horsepower, two-cylinder Diesel engine, driving a three-stage vertical compressor placed between the working cylinders. This engine also drives the centrifugal cargo discharging pump by a long belt and the centrifugal bilge and circulating pumps by chains. There is also a horizontal Deutz engine direct-coupled to the dynamo for lighting purposes, and also driving a small auxiliary compressor and a steam turning engine. A donkey boiler is fitted in the engine room, which can be fired by the exhaust gases of the main engine or by liquid fuel. The reliability of this vessel, as well as that of all the other large motor ships to which the author had access, is commented upon most favorably. In this connection it is pointed out that where compressed air is to be used for driving winches, windlasses, steering gear, etc., a supply should be drawn from a set of receivers entirely independent of those used for starting the engine, otherwise serious accidents might result. 12 illustrations. 9,300 words.—*The Engineer,* November 15 and 22.

Electric Power in Railway and Marine Terminals.—By R. H. Rogers. This article shows what Seattle is doing to prepare itself for the trade boom which is due to follow the opening of the Panama Canal, and shows how electricity can and must be applied to all the details of the terminal business if they are to overcome their great and growing handicap. The Bush Terminal, Brooklyn, N. Y., is cited as practically the only complete example of a modern steamship terminal, and it is pointed out that not only Seattle is working up a definite plan for progress in this direction, but also other cities, especially Boston, Los Angeles, San Francisco, New Orleans, etc., are waking up to the necessity for improving their waterway terminals. 9 illustrations. 2,500 words.—*General Electric Review,* June, 1912.

Motor Ship Rolandseck.—The *Rolandseck,* a ship 290 feet long, 40 feet beam, carrying 2,700 tons on 18 feet 4 inches draft, built by J. C. Tecklenborg, A. G., of Geestemunde, is propelled by a Carels-Tecklenborg six-cylinder engine with two-cycle cylinders, 20 inches by 36 inches, giving a horsepower of 310 for each cylinder. The engine with its self-contained auxiliaries, but no other parts or piping, weighs about 180 tons. The auxiliaries include a donkey boiler, a four-cycle 100 horsepower two-cylinder Diesel engine, driving an auxiliary compressor and a smaller one of the same general design for the dynamo, together with steam feed pumps, turning engine, etc. The mechanical efficiency is given as 73 percent. With this efficiency the indicated horsepower is 1,860, which works out to a brake horsepower of 1,360 at 115 revolutions. The fuel consumption is given as .47 pound per brake horsepower per hour. The article criticises the mechanical details of the engine and compares it with similar installations in other vessels. 5 illustrations. 3,350 words.—*The Engineer,* November 22.

Competition in Shipbuilding.—In an editorial discussion of this subject, attention is directed to the remarkable increase in shipbuilding in Germany as compared with the activity in England. At the commencement of October the number of merchant vessels under construction in the German yards was 101, with a total of 468,000 tons. With additional orders booked since then it is stated that German shipyards now have contracts on hand that will provide them with employment during the whole of 1913. Some of the important contracts in hand come from the Hamburg-American Company, which now has under construction nineteen ocean-going steamers of a total of 270,000 gross tons. Three of these are fast vessels for the Hamburg-New York service, each being of 50,000 tons. The North German Lloyd has seventeen steamers under construction with a total of 155,000 tons, the largest of which is 35,000 gross tons. At the beginning of November the German tonnage was exactly one-fourth of that obtaining in the United Kingdom at the same time, whereas the tonnage of merchant vessels launched in Germany, 1911, was only one-fifth of that launched in the United Kingdom last year. 1,000 words.—*The Engineer,* November 15.

The German Naval Architects.—The autumn meetings of the Schiffbautechnische Gesellschaft were held in the Konigl. Technischen Hochschule at Charlottenburg, Nov. 22 and 23. Seven papers were read and discussed. The first was by Dr. Diesel on the early development of the Diesel engine. It applies strictly to the period in which his engine was first developed, and does not discuss the period prior to or subsequent to this particular time, which of course had an important influence on the present-day development of the Diesel engine. The second paper was by Dr. Haufhäusen on the motive media of the Diesel motor with special regard to ocean navigation. The oils in use on Diesel engines at present are distillations of the fundamental substances coal tar and petroleum. The relative values of the various distillates are compared according to the percentage of hydrogen which they contain. The author draws practical conclusions for the treatment of fuels in order to obtain the best results in Diesel engines. The third paper, by Professor Dr. Gümbel, dealt with the problem of surface resistance. Of particular importance was that part of the paper dealing with the relation of surface resistance to the total resistance of ships. Of the two kinds of surface resistance, the resistance proper which is independent of the area and bears a certain relation to the roughness of the surface and the eddy resistance which depends on the lineal dimensions of the surface, it was by experiment unnecessary to separate one from the other. The next paper, "Internal Stresses, Especially the Tensile and the Resulting Ailments in Structural Parts," was by Professor E. Heyn. Certain mysterious breakages of turbine blades led to an investigation of the phenomena which indicate that a system is liable to internal stresses that produce elastic alterations of form. The special method of investigation made it possible to throw light on the very complicated effects of internal stresses and to arrive at ways and means of meeting them. The intensification of internal stress effects due to the working of the materials at a blue heat was illustrated, and this was considered to afford sufficient explanation of the well-known difficulty of working metals at temperatures within the limits of 150 degrees to 350 degrees C. The fifth paper, by Professor O. Flamm, dealt with the unsinkability of modern ships. The author shows that in connection with the German Bulkhead Rules, in which the curves given are concerned only with the sinking of vessels in a vertical direction without regard to their stability, and for a single draft. While the curves err on the safe side they should be revised to cover the matter of stability in individual cases. Professor Flamm advocated the institution of a central authority which should control the designs of sea-going vessels and that a class should not be given to such vessels until their qualities had been investigated. Three principal demands were formulated: (1) Replacement of the curves by exact calculations applied in each particular case; (2) the provision of sufficient stability to meet the case of a leaking vessel; (3) extension of the rules so far as to include all classes of vessels. The sixth paper, by Professor Otto Lienau, was on stresses in the longitudinal structure of steel merchant vessels. The principal results from investigations in this direction brought forth the following conclusions: (1) That the pressures exerted by weight of cargo and by water pressure respectively must not be discarded. (2) That the application of the longitudinal arrangement of the framing at the top and bottom parts of the longitudinal girder represented by the vessel brought with it an important reduction of stresses. Longitudinal framing at the sides and in the 'tween decks showed to less advantage, and the combination system was, therefore, considered to have approximately the same strength as the longitudinal one. The final paper, contributed by Oberlehrer Dipl. Mg. Herner, dealt with the reorganization of harbor dues and measurement for tonnage. The author makes the following proposals: The load displacement to form the basis of gross tonnage, in which case determination of the load line would have to precede that of the tonnage. The net tonnage to be identical with the cargo carrying capacity pure and simple, calculated by deducting from the displacement the weights of hull, machinery, coal, provisions, etc. Passengers to be included in the cargo. 12,250 words.—*The Engineer,* November 29, December 6.

Accidents to Lake Vessels.—During 1912 nineteen vessels on the Great Lakes were either total losses or constructive total losses. The most important loss was that of the steamer *James Gayley,* which was sunk in collision with the steamer *Rensselaer.* An analysis of the more important accidents developed the fact that nearly all of them could have been avoided by the careful observation of the rules of navigation.

All of the accidents since August 1 are tabulated in the article. 6,000 words.—*The Marine Review,* December.

Dominion Steamer Estevan.—The Collingwood Shipbuilding Company, Collingwood, Ontario, has just completed the twin-screw steamer *Estevan* to the order of the Dominion Government's Department of Marine Fisheries, and is especially designed to handle the lighthouse and buoy service on the Pacific Coast. The principal dimensions are: Length between perpendiculars, 200 feet; molded beam, 38 feet; molded depth to main deck, 17 feet 6 inches. The propelling machinery consists of two sets of triple expansion surface condensing engines having cylinders 15 inches, 25 inches and 42 inches diameter, with 26-inch stroke, running at 130 revolutions per minute. Steam is furnished by two Scotch boilers, 10 feet 6 inches by 14 feet diameter, working under Howden's forced draft. The steam pressure is 180 pounds per square inch. A special feature of the boat is the arrangement of a heavy derrick on the foremast for handling loads up to 30 tons. 1 illustration. 1,650 words.—*The Marine Review,* December.

The Use of Gases on Ships for Fire Extinguishing and Fumigation.—By E. Kilburn Scott. This paper, which was read before the Institute of Marine Engineers in November, is divided into two parts, the first dealing with fire extinction and the latter with fumigation. Four methods of extinguishing fire on board ship are enumerated: (1) Closing the hatches. (2) Flooding the holds with water. (3) Blowing in steam. (4) Blowing in inert gas, either carbon-dioxide, sulphur dioxide or flue gas. The various kinds of apparatus which have been developed commercially for fire extinguishing and fumigating are described in detail, as well as the installations of such apparatus. Information as to the properties of the various gases employed is given, as well as particulars relating to costs of the installation and upkeep. 11 illustrations. 9,000 words.—*Marine Engineer and Naval Architect,* December.

The Lengthening of the Aberdeen Liners Marathon and Miltiades.—Messrs. Alexander Stephens & Sons, of Linthouse, Govan, Glasgow, have recently lengthened by about 50 feet the Aberdeen White Star Liners *Marathon* and *Miltiades,* built by the firm in 1903. The length of these vessels was 455 feet on the water line, the breadth 55 feet, and the depth, molded to the upper deck, 33 feet. The portion added to each hull by the lengthening forms a new cargo hold having a cubic measurement of 83,000 feet and a cargo-carrying capacity of 1,200 tons deadweight. Space is also provided in the 'tween decks for accommodations for thirty first class and forty steerage passengers. No alterations or additions have been made to the propelling machinery except the provision of a second funnel, principally for appearance' sake. The article describes the process of lengthening these vessels. 8 illustrations. 2,000 words.—*The Shipbuilder,* December.

The Woermann Line Steamer Professor Woermann.—The single-screw passenger and cargo steamer *Professor Woermann* has been built for the Woermann Line by the Reiherstieg Schiffswerfts und Maschinenfabrik of Hamburg. The vessel is 391 feet 7½ inches long between perpendiculars, 52 feet molded breadth, 29 feet 6 inches molded depth to upper deck, 25 feet draft, corresponding to deadweight of 6,200 tons. The propelling machinery consists of one set of quadruple expansion engines with cylinders 26 inches, 38½ inches, 55½ inches and 81¼ inches diameter, with a stroke of 55 inches. The engines develop about 3,800 indicated horsepower at 70 revolutions per minute and are designed to give the ship a sea speed of 13½ knots when laden to about 22 feet 6 inches draft. Five single-ended cylindrical boilers with a total heating surface of 17,860 square feet supply steam at a working pressure of about 230 pounds per square inch. 3 illustrations. 750 words.—*The Shipbuilder,* December.

A Comparative Survey of Battleship Design.—This survey reviews only those types of battleships mounting the 12-inch gun. The vessels thus armed are divided into four distinct types: With guns in twin turrets carried on the center line and en echelon, on the center line only, on the center line and in wing turrets, and in triple turrets. The article is largely of a descriptive nature, enumerating and comparing the details of the various ships. German, Japanese, United States, Brazilian, Italian and Austrian ships of the line are discussed and their design and fighting qualities critically examined. The author concludes that the 12-inch gun era has practically closed. Credit is given to America for introducing the center line arrangement for turrets, to Germany and other nations for retaining the 6-inch gun, and to Italy for producing the triple turret. It is claimed that England has led in discarding the 12-inch gun before any other power, and substituting therefor the 13.5-inch and now the great 15-inch weapon, thus obtaining an invaluable lead over all other powers. 7 illustrations. 4,500 words.—*The Shipbuilder,* December.

The Argentine Torpedo Boat Destroyer Jujuy.—The *Jujuy* and her sister ship, the *Catamarca,* belong to a class of twelve vessels ordered by the Argentine Government from English, French and German firms in 1910. These two vessels were built by Freid. Krupp, A. G., at their Germania yard at Kiel. They are 289 feet 2 inches long over all, 286 feet 6 inches long on the water line, 27 feet breadth extreme, 17 feet ¾ inch depth, 8 feet 8½ inches normal draft, 995 tons normal displacement, 1,290 tons maximum displacement. The article gives a very detailed description of the construction and arrangement of the vessel, supplemented by a number of photographs and detailed drawings of both hull and machinery. The armament consists of four 4-inch 50-caliber quick-firing guns and four 53-cm. deck torpedo tubes of the Whitehead type, 21 feet long. The vessel is propelled by twin screws, each screw being driven by a Germania steam turbine of 12,000 shaft-horsepower running at about 640 revolutions per minute. The speed of the turbines is regulated, in so far as the change from the cruising to the normal speed is concerned, by varying the nozzle inlets to the first stage and regulating the maneuvering valve. For this purpose two sets of nozzles are provided, one of which is used for the cruising speed of about 15 knots and the other for the normal speed of about 28 knots. The turbines were tested in the shop up to 8,000 shaft horsepower. The steam consumption when developing 7,250 shaft horsepower was found to be only 12.25 pounds per shaft horsepower per hour. As this was only 60 percent of the full power, a still better result was to be expected at full load. The propellers are four-bladed, about 7 feet 6 inches diameter. The boiler installation consists of five small-tube water-tube boilers of the Germania-Schulz type, four arranged for coal burning and one for oil burning. Each boiler has a heating surface of 4,400 square feet and a grate surface of 97 square feet. The heating surface of the oil-burning boiler is 8,300 square feet. The working steam pressure is 260 pounds per square inch. It has been said that the German-built vessels of this group of destroyers have proved the most successful, and consequently the lengthy technical description of the vessel and her propelling machinery, together with the complete plans presented in the form of folding plates, will make this article of more than usual interest to warship builders. 11 illustrations, 2 plates. 4,000 words.—*The Shipbuilder,* December.

CONTRACTS FOR NEW DESTROYERS.—Contracts for six torpedo boat destroyers for the United States navy authorized at the last session of Congress were awarded in December as follows: The William Cramp & Sons Ship & Engine Building Company, of Philadelphia, Pa., three vessels; the Bath Iron Works, Bath, Me., the Fore River Shipbuilding Company, Quincy, Mass., and the New York Shipbuilding Company, Camden, N. J., one vessel each.

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McAndrew's Floating School

It is much easier for some to read a good story and remember the thousand and one ludicrous incidents related in it than it is to read a text-book, no matter how useful the information it contains may be, and it is for these men that we have begun publication of "McAndrew's Floating School," a serial story which tells how four young firemen, starting at the very beginning of a seafaring career below the grating of a steamship, gain the necessary knowledge for their advancement, step by step, to the positions of licensed marine engineers. All that the law requires them to know to get their licenses, either from the Board of Trade or the United States Steamboat Inspection Service, is woven into the story, so that the reader unconsciously absorbs a vast amount of practical and necessary information. The story is written by one of the best-known writers on marine engineering subjects, Captain C. A. McAllister, Engineer-in-Chief of the United States Revenue Cutter Service, a man who is by no means a stranger to many of our readers, since he has been a frequent contributor to our columns and was the author of the splendid engineering story, "The Professor on Shipboard," published several years ago. The new story that we are now publishing cannot fail to be of interest to every engineer, and it will be found particularly useful and helpful to the beginner.

The Technical Graduate

In view of the fact that shipbuilding is usually carried on of necessity by large corporations employing thousands of men engaged in a great variety of trades, it would seem natural that the system of management in such extensive enterprises would be developed to the highest point of economic efficiency, capable of dealing with every condition which would tend to strengthen its organization and produce the best possible results in face of the strongest competition; and yet cases are not infrequent, particularly in American shipyards, where there is a strange apathy on the part of the management to deal in a systematic way with the development of the technical graduate. Since the success of a shipyard depends largely upon the work of a competent staff of highly trained engineers, it is certainly a matter of some moment to look to the proper training of the recruits for this work. Are we to infer from the attitude of the management that the technical graduate is of little or no value to the shipbuilder? Or is this task of developing the technical graduate into a practical shipbuilder or naval architect too great a burden for the shipbuilder to undertake, considering the probable value of the technical man after he has secured a few years of practical experience?

There is no doubt that the technical graduate coming to the shipyard directly from an engineering school is heavily handicapped by the lack of practical experience, so that his first efforts in company with a force of trained apprentices and skilled mechanics are necessarily crude and perhaps of little value to the employer. But even so, it is certainly a shortsighted policy on the part of the employer to cast aside the technical graduate as a nuisance and a hindrance on the plea that he can secure from the ranks of his apprentices a more valuable man, thoroughly familiar with the tools, methods and materials involved in the particular work for which his services are needed immediately. There is, of course, a striking contrast between the technical graduate immediately after the completion of his course at an engineering school and the practical apprentice who has spent an equal length of time in actual work in a shipyard; but the relative value of the two types of men cannot be judged fairly by simply appraising the value of the raw material which, for the moment, both represent. The true value of both to the employer lies very largely in what can be made from the raw material. The technical graduate has a firm foundation of engineering knowledge on which to build, but he lacks practical experience. On the other hand, the practical man is thoroughly acquainted with the actual methods and processes of ship con-

struction, but he lacks the strictly scientific training which is most essential for advancement. The most valued men in a shipyard must be technical men, no matter whether their technical knowledge has been gained partly from an engineering school education or almost wholly by practical experience in a shipyard or engine builder's shop, together with outside study; and the numerous examples of apparently equal progress and success of both types of men in the same field leads to the conclusion that both the technical graduate and the practical man have much in common that is of value, and that to neglect or slight available opportunities for aiding either is simply throwing away good material.

The methods employed in certain foreign countries for the training of technical graduates by practical work in the shipyards, as cited elsewhere in this issue, have much to commend them that is worthy of careful study. What has proved successful in these cases could undoubtedly be adapted to advantage to the conditions prevailing in America. Summer work for engineering students is of particular advantage, especially if backed up by a systematic scheme for providing a term of apprenticeship for the technical graduate, during which he would have a fair opportunity of becoming thoroughly familiar with all the activities of the shipyard, and the employer, in turn, would have an opportunity to gage his fitness for the more important work which is really the field for which he has been preparing as a life-work. The outcome in any case, of course, depends, among other things, upon the individuality of the man, and right here is a chance for the technical graduate to show the value of his education. Besides the engineering knowledge he has acquired, he has been under the influence of associations most beneficial to the development of character. He has faced the necessity of hard work, and plenty of it; he has been trained to learn rapidly, and has the ability to use his training in an emergency. Self-reliance, ambition and steadfast purpose are seldom lacking in the true technical graduate, and if the shipbuilder meets him half way he is almost certain to profit by these characteristics in the end. Otherwise, the technical graduate is likely to drift into other fields of engineering, and the shipbuilder will have lost a valuable opportunity to develop a most useful type of employee for his special needs.

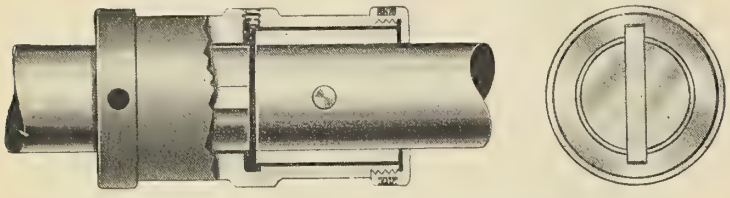
Port Development

With the nearing completion of the Panama Canal men in all parts of the United States are beginning to recognize the necessity, and, at the same time, the opportunity, for the investment of local capital in new steamship lines to meet the demands of increased commerce between ports on the Atlantic and Pacific Coasts and to South America through the Panama Canal. The possibilities for an immediate increase in commerce to the twenty countries of Latin-America is indicated by the fact that the foreign commerce of these countries last year exceeded a total of $2,300,000,000 (£473,000,000), a sum which represents a growth of $1,000,000,000 (£205,500,000) in the last ten years. The share which the United States has in this foreign trade will probably amount this year to as much as $700,000,000 (£144,000,000), and this, too, represents an increase of nearly 100 percent in the last decade. Under such conditions there is, therefore, excellent opportunity for an enormous advance in this commerce when the Panama Canal is completed. That the benefits of the Panama Canal are being recognized even more fully in foreign countries than in the United States is evident from the fact that the largest ports of Europe are spending now, or are preparing to spend, enormous sums for the establishment of new steamship lines or the extension of existing lines. It has usually been the policy in most European ports to look ahead and provide for the future in the development of port facilities. In almost every case, however, the progress in maritime commerce has repeatedly exceeded expectations and further development has been found necessary. Liverpool, for instance, is already severely embarrassed by the lack of adequate facilities to accommodate the existing commerce, and immediate steps are being taken for the relief of these conditions. It is strange that American ports should lag so far behind the general world-wide movement for the extension of port facilities, but the fact remains that most of them, and particularly the largest of all—the port of New York—has been at a standstill, so far as improvements are concerned, for several years. No less than thirty-two applications from steamship companies are on file waiting for terminal accommodations in the city. Steamships larger than the present piers can accommodate will be ready to enter the New York service within a few months, and still improvements are delayed. No more serious handicap can be placed upon the trade and commerce of any port than the lack of adequate piers and berthing facilities for the steamers which are available, and it is to be hoped that immediate and progressive action will be taken to relieve these conditions. No one can realize better the urgent need of immediate port improvement than the seaport authorities themselves, who are directly in charge of these matters, and an encouraging step has been taken in the United States by the formation of a national association of port officials, made up of the executive officials of all the important ports of the Atlantic, Gulf and Pacific Coasts, with the object of advancing port development projects by bringing into intimate relation those who are now directing such improvements along individual lines. The concerted action of such an organization should do much to bring before the public the best types of equipment to meet specific conditions.

Improved Marine Engineering Specialties

An Improved Steel Coupling for High or Low Speed Shafts

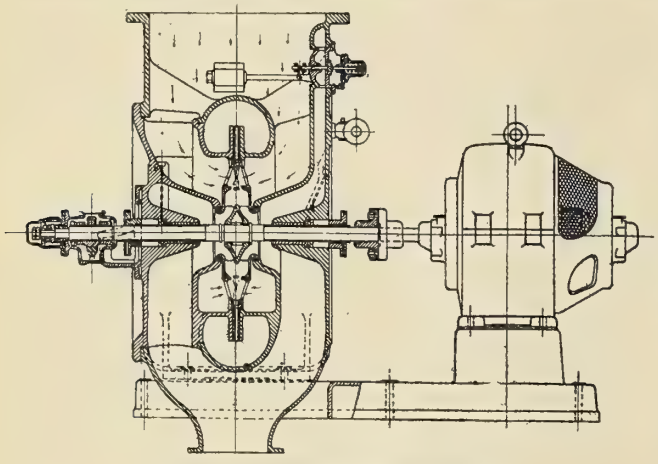
A new form of flexible coupling, made entirely of crucible cast steel and to dimensions especially suitable for this material, is being introduced by McEwen Bros., Wellsville, N. Y. This McEwen coupling, as it is called, and as illustrated herewith, is said to have the smallest diameter and mass, and therefore the smallest inertia of any truly flexible coupling on the market. The keys extend clear through the shafts, are set at right angles and are arranged to permit a marked degree of misalinement, yet because of ample key-bearing surface and the exceptionally good lubrication from packing of heavy



oil or soft grease, there is no noise or tendency toward serious wear. The design is particularly good for withdrawals parallel to the shaft axis, and very small clearance is required for removing any part. This type of coupling was first used, and has been given its severest test upon McEwen Bros. pumps, direct connected to steam turbines running twenty-four hours per day for months at a time. The satisfaction which it has given under these high speeds and other severe conditions as reversible motor drive for machine tools, would seem to indicate a general usefulness for blower, rotary pump, motor, generator and turbine and line shaft connections and on other machinery of any speeds.

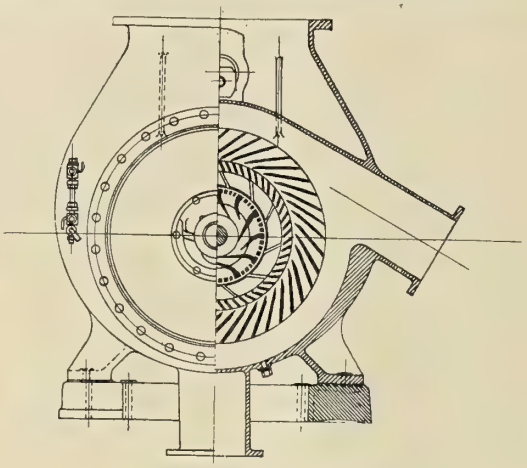
Rees Roturbo Rotary Jet Condenser

A new type of rotary jet condenser and high vacuum rotary air pump has recently been placed on the market by the Manistee Iron Works Company of Manistee, Mich., which is the American licensee of the Rees Roturbo Development Syndi-



SECTION OF ROTARY JET CONDENSER

cate, Ltd., of Wolverhampton. The new condenser is a development of the Rees Roturbo centrifugal pump, described in our October, 1912, issue, the unique feature of which is the employment of a revolving hydraulic accumulator or pressure chamber. In the case of the condenser this pressure chamber is used to lift the condensing water as an ordinary centrifugal pump would lift it to any height up to a limit of 20 or 25 feet, and give it an initial pressure after raising it. The water, therefore, flows up the suction pipe into this revolving pressure chamber or water drum, on the periphery of which nozzles are arranged. These nozzles allow the water to escape



END VIEW AND PART SECTION

from the pressure drum in radiating jets which are arranged to impinge in pairs. By this means the water jets are made fan shaped and subdivided into a fine spray, and are projected in lines radiating from the shaft (but still rotating as a whole with the impeller) across a space into which the steam is allowed to exhaust through openings. As these fan-shaped jets are rotating edgewise at a comparatively high speed, the area swept by them is very great, although the space occupied by the impeller is comparatively small. This, it is claimed, insures a perfect mixture of steam and water and an ideal condition for the most rapid and perfect condensation. After the water jets have traveled radially some distance, so that the broad parts of the water fans have all combined to form a complete ring of spray and condensed the steam, the problem, as in the case of all other condensers, is to extract the condensate and air with certainty and efficiency, and it is at this point that the new condenser differs in principle from all other types.

Instead of giving the water jets, as they leave the injection nozzles in the drum, sufficient energy to extract themselves from the vacuum chamber and carry with them without further assistance the air and condensate, the rotating jets of spray or condensate with the entrained air are in the Rees Roturbo condenser picked up by the blades of an exhausting fan concentric with the rotating pressure drum and of a much larger diameter, leaving a large steam space between the water drum and the exhausting fan, the whole forming a single rotary member. By means of the exhausting fan the condensate with the entrained air is ejected with absolute certainty and efficiency.

Fundamentally these rim blades are the equivalent of the mixing cone, and the neck or "shock zone" of the old ejector adapted to be rotated to give a positive exhausting effect, due to centrifugal force. These exhausting fan blades also form an automatic regulator, which deals with fluctuating conditions of steam or vacuum without any speed regulation. This feature allowing for long jets and a greater area for condensation than was possible even in the ejector condenser, as well as the impinging jets, which form the finest spray, enables the apparatus to be used for the largest size condensers, without any auxiliary apparatus for extracting the air or condensate, and carries all the advantages enumerated when used in the smaller sizes, as dry air pumps for surface and other types of condensers.

Waterprooofing the Floors of Piers

In building piers it is modern practice to specify that the floors, whether they be of mill construction or of concrete, should be thoroughly waterproofed. In the case of concrete, the solution is comparatively simple, inasmuch as painting with a preparation of boiled linseed oil thinned down with gasoline (petrol) will make the concrete impervious to moisture. Several coats of this should be applied until the oil shows glossy on the top.

However, in the case of mill floors the procedure is somewhat different. In the ordinary mill floor the construction usually consists of an under-flooring of 3-inch or 4-inch pine plank with a maple top of ⅞ or 1 inch and an intermediate

floor of similar dimensions. The general practice is to lay the top and under-flooring the length of the building, while the intermediate flooring is placed diagonally. Between the top and intermediate flooring is placed a waterproofing felt cemented together with an elastic compound, which snugly and tightly fills the nail points. Each sheet is lapped 19 inches over the preceding sheet of waterproofing, being turned up 2 inches at walls and openings, and also around columns, pipes, etc. At times to insure better results, as each plank of the top floor is laid, the hot compound is spread under it and over the felt already in place, making the joints between the top flooring itself practically watertight. Building paper could not possibly stand the severe conditions and a felt should be used which is absolutely impervious to water.

In this connection it is interesting to note the construction used at the steel and concrete piers of the North German Lloyd Steamship Company. Here the mill floors were waterproofed with two layers of "Hydrex" waterproof felt under the maple floor wearing surface. This material is exceptionally pliable and elastic, and does not dry out and disintegrate from the effects of the ocean air and salt water. The floors of the auditorium and ball room on Young's Million Dollar Pier, of Atlantic City, are also waterproofed with this felt against the high waves and salt spray of the sea below. The felt has remained tough and flexible, while an ordinary building paper by this time would have become practically worthless. The Atlantic City pier is also waterproofed with the same material.

The value of waterproofing the floors of piers and docks where merchandise is stored below is not as generally appreciated as might be expected, when it is considered in cases of fire that floors properly waterproofed prevent the water from pouring through to the floor below and increasing the loss. Waterproofed floors confine the water used in extinguishing fires to a given area. The ordinary building paper cannot accomplish this result and simply keeps dust from going through floors. Fire underwriters and insurance companies strongly endorse waterproofing floors, and make an allowance on the insurance which soon pays for the installation of the waterproofing.

Marine Repairs by Thermit Welding

Welding by the thermit process, as carried out by the Goldschmidt Thermit Company, New York, is accomplished by pouring superheated thermit steel around the parts to be united. Thermit steel is produced by the mechanical reaction between finely divided aluminum and iron oxide when ignited. This reaction when started in one spot continues throughout the entire mass without the supply of heat or power from outside sources, and produces superheated liquid steel and superheated liquid slag at a temperature of approximately 5,400 degrees F. From thirty seconds to one minute is sufficient time to bring into reaction almost any amount of thermit.

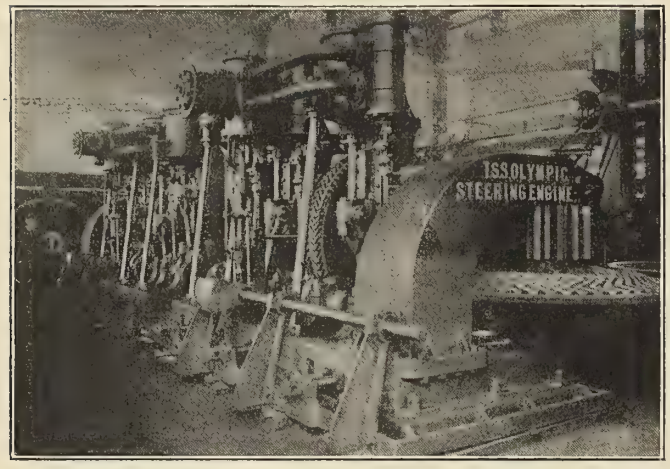
In repairing broken stern posts, rudder frames or rudder stocks, as shown in the accompanying illustration, a mold is built around the ends of the sections to be united, after the sections have been thoroughly cleaned and enough metal removed to allow for a free flow of thermit steel. The parts to be welded

should be preheated by means of a gasoline (petrol) torch; the thermit is then ignited in a crucible suspended over the pouring gate of the mold, and then the thermit steel is poured. When the thermit steel is poured it dissolves the metal with which it comes in contact and amalgamates with it to form a single homogeneous mass when cooled. Unless the sections to be united are preheated before pouring the thermit steel they will exert a chilling effect on the incoming metal and prevent successful fusion.

One of the important advantages gained by this form of welding is the possibility of welding heavy sections of wrought iron or steel without removing them from their position on board a ship, and therefore effecting a great saving in time and expense over other methods of repair. Sometimes it is found unnecessary to place the vessel in dry dock in order to make the repairs, and aside from the supply of compressed air for the operation of pneumatic tools and the preheating torch, no outside power is required, and since all the materials and appliances used for making the welds are light and portable they may be brought to the job. Where parts to be welded can be removed without trouble or great expense, it is found economical to forward them to one of the company's shops, where the repairs can be made immediately.

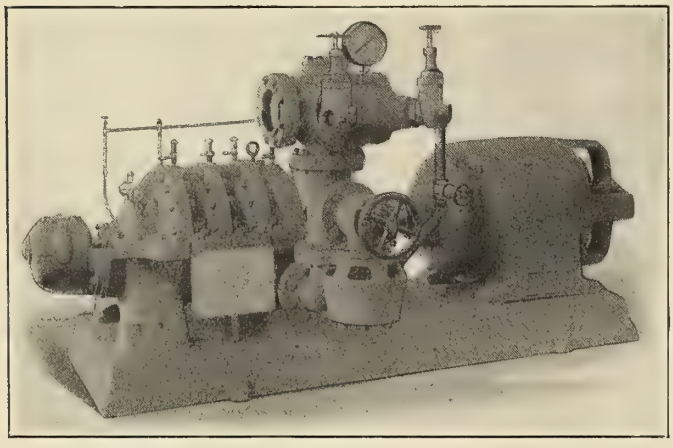
Citroën Gears

The accompanying illustration shows the steering gear for the White Star Liner *Olympic,* in which are used double Herring-bone helical reverse gears supplied by André Citroën & Company, 27 Queen Victoria street, London, E. C. These gears are of interest from the fact that they can be applied for the transmission of power under the most disadvantageous conditions. For reversing gears, such as are necessary in marine steering machinery, ordinary helical gears with the apices of the teeth running in a forward direction will rapidly wear out when called upon to reverse if transmitting the same load in both directions. To overcome this, the Citroën gears are made with three sections of the double Herring-bone type, as shown in the illustration, and this type of tooth is now being adopted for all reversing gear, especially in marine machinery. The Citroën gears are genuine machine-cut helical gears, as they have continuous teeth automatically cut with one tool in a single operation in the solid metal. This company has supplied gears for the steering machinery for a large number of battleships and submarine boats, as well as for merchant vessels.



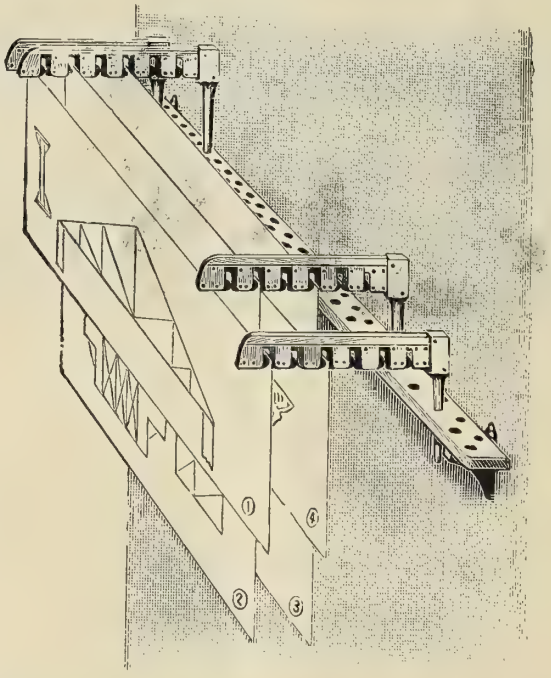
New Centrifugal Fire Pump

A new design of centrifugal fire pump has just been developed by The Goulds Manufacturing Company, Seneca Falls, N. Y., and is handled in England by Messrs. Gillespie & Beals, Amberely House, Norfolk street, The Strand, London. The outfit is furnished complete with pump, electric motor (a. c. or d. c.) or steam turbine, bed plate and all fittings required by the fire insurance companies, and it has been approved by the Association of Mutual Factory Fire Insurance Companies. Four sizes are furnished, with capacities of 500, 750, 1,000 and 1,500 gallons per minute, being sufficient for two, three, four and six effective fire streams respectively. All working parts are made of bronze to prevent any corrosive action from the water. The outfit illustrated is a 500-gallon equipment for two effective streams. With 250-foot leads of smooth hose and 1⅛-inch nozzle, the pressure at the nozzle is 50 pounds per square inch. This will produce an effective stream in a moderate wind at a vertical height of 70 feet and a horizontal distance of 63 feet. The motor with this outfit runs at 1,700 revolutions per minute and has an output of 50 horsepower. The overall dimensions of the complete outfit are: Length, 9 feet 7 inches; width, 6 feet 3 inches; height, 4 feet 9 inches.



Engineers' Photo Drying Rack

H. Schery & Company, Manchester, has placed on the market a convenient device for drying engineers' prints. The construction of the rack will be seen from the illustration. The mere insertion of the print into the clip will hold it securely, and a touch of the finger will release it again. The print is stretched out evenly over the whole surface and will, therefore, dry without creasing or crumpling. A number of prints can be dried at the same time occupying a very small space.



TECHNOLOGY REUNION.—The Alumni of the Massachusetts Institute of Technology, Boston, Mass., will meet for a two days' reunion at the Hotel Plaza, Fifty-ninth street and Fifth avenue, New York City, Jan. 17 and 18. The four principal events of the reunion will be departmental luncheons and a mass meeting on Friday, Jan. 17, and class luncheons and the annual alumni banquet on Saturday, Jan. 18. At the departmental luncheons on Friday the heads of the various departments at the Institute will tell something of what has been going on at Technology in recent years. Professor C. H. Peabody, head of the Department of Naval Architecture and Marine Engineering, will address the graduates of this course, and other men, prominent as naval architects and shipbuilders, will tell what is being accomplished by graduates of the Massachusetts Institute of Technology in their profession.

Technical Publications

STEAM BOILERS AND BOILER ACCESSORIES. By W. Inchley, B. Sc. Size, 4¾ by 7¼ inches. Pages, 412. Illustrations, 140. New York, 1912: Longmans, Green & Company. Price, $2.40 net.

As this book is intended to meet the requirements of steam users and engineering students rather than boiler manufacturers, it may seem incomplete to one familiar with the countless details of boiler shop practice. Technical details of boiler construction, such as the pitch of rivets, strength of plate, etc., are purposely omitted, however, since the class of readers for which the book is written is not necessarily concerned with such matters. A general description of various types of fire-tube and watertube boilers is given, and the questions of fuels and combustion, draft, generation of steam and heat transmission are thoroughly treated. A large amount of space is taken up with the description and explanation of the operation of every conceivable boiler accessory, the final chapters dealing with the practical operation of boilers and carrying out of steam boiler trials.

OXY-ACETYLENE TORCH PRACTICE. By J. F. Springer. Size, 5 by 7¼ inches. Pages, 140. Numerous illustrations. New York, 1912: The Richardson Press. Price, $2.50 net.

The welding and cutting of metals, particularly of boiler steel, by means of an oxy-acetylene torch, have become of such importance in recent years that most boiler makers are familiar with the general principles of these operations, and many have seen at first hand the results of the practical operation of the process. There is a vast difference, however, between experiment and approved practice, and it is the object of this book to set forth an accurate account of approved practice in the application of oxy-acetylene welding and cutting. The book was prepared with the co-operation of a prominent manufacturer of such apparatus, and is, therefore, based on wide experience and sound judgment. The book is not confined to boiler work; in fact, only a short chapter deals with boiler work; other parts of the book, however, deal in a complete manner with various types of sheet metal work, and of particular interest are chapters which take up the restoration of steel, welding as a calking process, and an investigation of the question as to whether or not oxy-acetylene cutting injures metal.

PRACTICAL DESIGN OF MARINE SINGLE-ENDED AND DOUBLE-ENDED BOILERS. By John Gray. Size, 5 by 7¼ inches. Pages, 84. Figures, 21. Plates, 4. New York, 1912: D. Van Nostrand Company. Price, $1.25.

It is claimed that this is the only book on the market dealing solely with the design of high-pressure single-ended and double-ended marine boilers. It is true that almost every book on boiler design or construction is concerned chiefly with the general principles of boiler construction and the details of stationary boilers, with perhaps a short chapter devoted to the design of marine boilers. A more complete treatment is needed, however, to enable a draftsman to work out the complete design of a Scotch boiler. In recent years steam pressures have steadily increased on board ship, and as larger ships and greater speed seem to be the prevailing tendencies in modern shipbuilding, it is necessary for the draftsmen or engineers engaged in their design to study in detail the construction of the large four-furnace high-pressure boiler. This book is an admirable aid for this purpose, and a copy should be in the possession of anyone who has to do with the design and construction of marine boilers.

A HAND-BOOK ON THE GAS ENGINE. By Herman Haeder. Translated by William M. Huskisson. Size, 6½ by 9¼ inches. Pages, 317. Numerous illustrations. London, 1911: Crosby, Lockwood & Son. Price, 18s. net.

This book comprises a practical treatise on internal-combustion engines for the use of engine builders, engineers, mechanical draftsmen, engineering students, users of internal-combustion engines and others. The original book was written in German, although not confined to German practice, and the work has been ably translated into English. It should prove of particular value to the engine builder or designer, because of the comprehensive treatment of the design of the various parts of an internal-combustion engine. In a single chapter there are seven sections which deal, respectively, with the crankshaft, the main bearings, frame, cylinder, piston, connecting rod, fly-wheel and relative costs of working gas and steam engines. The various parts of the engine are not only thoroughly described, but the methods of calculation, with questions and examples, place the material in convenient form for practical application. The book is profusely illustrated with line drawings and plates, and in an appendix there is a splendid collection of useful tables, which are a valuable accessory to gas-engine design.

THE STEAM TURBINE. By Robert M. Neilson. Size, 6 by 9 inches. Pages, 651. Illustrations, 415. New York and London, 1912: Longmans, Green & Company. Price, 18s. net.

As this is the fourth edition of this work the general scope of the book is probably familiar to many of our readers. This edition, however, has been completely revised and enlarged, to include important developments in design and use of steam turbines, which have taken place within the last few years. The greater portion of the previous edition has been rewritten and much additional matter, including seven completely new chapters, has been added. The author's aim throughout has been to render the subject intelligible to the average British or American engineer, who has had a fair but not necessarily a very extensive scientific training. For this reason the theoretical part of the subject has been subordinated to practical descriptive matter, although the two, of course, cannot be separated. The part of the book relating to marine steam turbines is confined to a single chapter, and describes the application of different types of turbines for this purpose, together with illustrations of the arrangement of the installations.

AN UNSINKABLE TITANIC. By Bernard J. Walker. Size, 5 by 7½ inches. Pages, 185. 30 illustrations. New York, 1912: Dodd, Mead & Company. Price, $1.00 net.

This book is an earnest appeal for the construction of safer passenger vessels by embodying in their design a more minute subdivision of the hull. The famous *Great Eastern* is cited as an example of what the author considers the safest ocean liner ever built, and with this design are contrasted the defects of modern passenger vessels. This striking contrast is further emphasized by comparing the modern passenger steamship with warship construction, where minute subdivision of the hull is a leading characteristic. The book is evidently written for the popular reader, and if it is successful in augmenting the popular demand for safer steamship construction it will have served a useful purpose.

Obituary

ROBERT MCMILLAN, head of the firm of Messrs. Archibald McMillan & Son, Ltd., of the Dockyard, Dumbarton, died suddenly Nov. 2, at his home, aged 69 years. Mr. McMillan is the third generation of McMillans who have been actively engaged in the shipbuilding industry since 1834. This was the first firm in Great Britain to apply hydraulic power to the riveting of iron ships. Recently they have specialized in large cargo-carrying steamers, built on the Isherwood longitudinal system.

JOHN WILLIAM SHEPHERD, recently managing director of the London & Glasgow Engineering & Iron Shipbuilding Company, Ltd., Govan and Lancefield, Glasgow, died Nov. 24, in Glasgow, aged 68 years. Mr. Shepherd has had a very varied experience as a shipbuilder. From his early training in the Sherness Dockyard he has been prominently identified with many of the large Scotch shipbuilding firms.

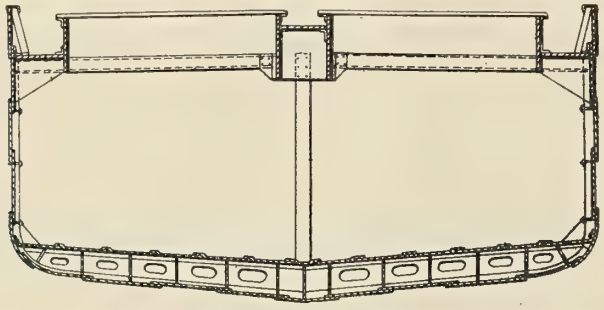
Selected Marine Patents

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,033,403. MULTIPLE-HATCH CONSTRUCTION FOR VESSELS. EDWARD S. HOUGH, OF SAN FRANCISCO, CAL.

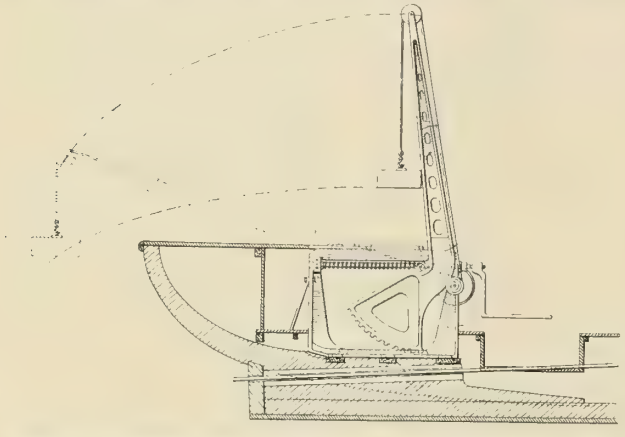
Claim 1.—A vessel having twin hatches, strengthening girders extending longitudinally upon each side of said hatches, a central girder



of inverted box-like form, vertical supports between said girder and the keelson, and transverse deck stays extending between the central and side girders. Two claims.

1,034,128. CRANE OR DAVIT. ANDREAS P. LUNDIN, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO ASTOR TRUST COMPANY, TRUSTEE, A CORPORATION OF NEW YORK.

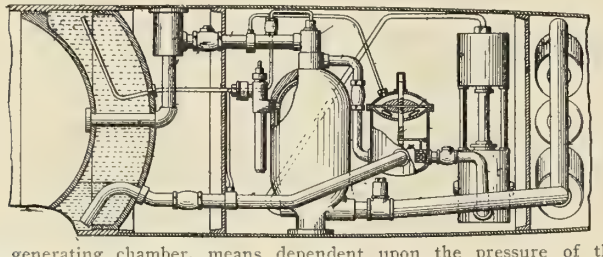
Claim 1.—A crane having a lower portion provided with a segment having two sets of teeth arranged on either side of a track, in combination



with a rack provided with an intermediate rail upon which the track rolls and two sets of teeth on each side of said rail adapted to engage and co-act with the teeth on the segment. Seven claims.

1,036,081. MOTIVE-FLUID-GENERATING APPARATUS FOR AUTOMOBILE TORPEDOES. GREGORY CALDWELL DAVISON, OF QUINCY, MASS., ASSIGNOR TO ELECTRIC BOAT COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

Claim 3.—In apparatus for generating motive fluid for automobile torpedoes, a generating chamber in which an oxygen-carrier and fuel are burned, means for supplying the oxygen-carrier under pressure to



the generating chamber, means dependent upon the pressure of the oxygen-carrier for supplying the fuel under pressure to the generating chamber, an ignition device, and connections whereby the actuation of the ignition device is dependent upon the pressure of the fuel. Eight claims.

1,035,021. SAFETY-WEIGHT FOR SUBMARINE VESSELS. MAXINE ALFRED LAUBEUF, OF PARIS, FRANCE.

Claim 3.—A submarine vessel provided with pockets fore and aft; a weight mounted in each of said pockets, the bottom of the weight standing at a point above the bottom of the hull of the vessel; and means located amidship for releasing one or the other or both of said weights and permitting the same to pass out of the pockets. Nine claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C., London.

14,314. ALLOYS FOR PROPELLERS. A. K. HUNTINGTON AND F. G. P. PRESTON, BOTH OF LONDON.

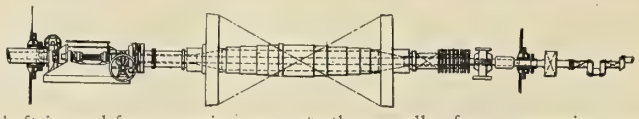
Alloys for use in making ships' propellers contain copper, zinc 34-42 percent and aluminium 1.75-4 percent, together with a little manganese and iron. Other constituents, such as lead, may also be present in small quantities, but the presence of tin and nickel is undesirable. Specification 232-10 is referred to.

20,383. ELECTRIC BOAT HOISTS. J. FIELDING, GLOUCESTER.

The object of this invention is to keep the electrically operated hoisting tackle of ships' boats taut as the boat rises and falls with the waves, and this is effected by interposing a suitable slipping clutch between the driving motor and the hoisting drum so that the motor may continue to rotate in one direction while the movement of the drum may be arrested or even reversed. A variable pressure betwen the clutch members may be applied by means of an electromagnet, the circuit of which is controlled by a switch conveniently mounted with respect to the motor switch.

21,977. PROPULSION OF VESSELS. A. F. YARROW, STIRLINGSHIRE, SCOTLAND.

This invention relates to the propulsion of vessels which are provided with two propelling engines, such as a steam turbine and an internal-combustion engine, for driving the same screw propeller. A hollow



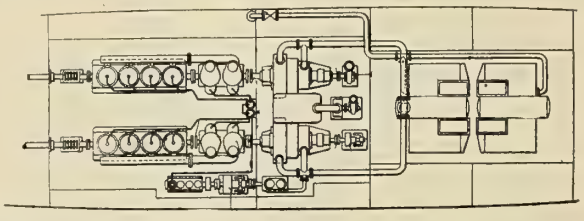
shaft is used for conveying power to the propeller from one engine, and another shaft passing through the hollow shaft for conveying power from the other engine, clutches being provided for coupling either engine to drive the propeller independently of the other engine.

24,324. CLUTCH AND REVERSING GEAR FOR MARINE MOTOR SHAFTS. A. G. LANGDON AND S. KELLAWAY, SOUTHAMPTON.

The apparatus comprises a double friction cone for the forward drive, the forward cone being keyed to the driven shaft, and the after cone being free to slide on the driven shaft. A stiff coil spring is fitted between the friction cones and extends to cause them to engage a double cone case, the forward end of which is connected to the driving shaft, and the after end with a toothed wheel keyed to the cone case, and mounted over this wheel is a drum provided with a band brake and carrying intermediate toothed gear, a portion of which comes into contact with the wheel on the cone case, the remaining part of the wheels coming into contact with another wheel keyed to the driven shaft, which runs right through the gear, and on which the friction cones are keyed so that a reverse is obtained.

10,240. ARRANGEMENT OF ENGINES FOR PROPULSION. GEBRUDER SULZER, WINTERTHUR AND LUDWIGSHAFEN.

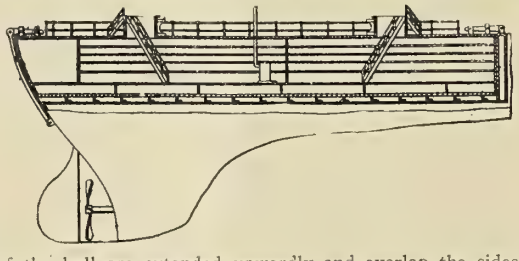
This invention relates to an arrangement of steam turbines and continuous-combustion internal combustion engines allowing ships to be always driven in the most economical manner. To this end charging and compressed air pumps are arranged in the length of the propeller shaft between the steam turbine and internal-combustion engine, these



pumps having clutch couplings enabling them to be disconnected or connected to the turbine or to the internal-combustion engine alone, or to both engines simultaneously, independent auxiliary machines, such as air pumps, bilge pumps, dynamos, etc.; being also capable of being coupled to the two engines working either jointly or independently.

11,858. SHIPS. R. S. CLIFT, QUEBEC.

This invention relates to ships provided with deck-houses or compartments constituting part of the boat under normal conditions and adapted to be loosened from the hull in case of accident. The side



plates of the hull are extended upwardly and overlap the sides of the pontoon to prevent lateral displacement of the latter. The pontoon is locked against rearward displacement by releasable devices consisting of arms pivoted to stanchions on the deck of the vessel and adapted to be swung down and secured between pairs of lugs on the deck.